THE EFFECTS OF VIOLATIONS OF BAR CHART STANDARDS ON MANAGERIAL DECISION MAKING

THESIS

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The views expressed in this thesis are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

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THESIS

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Master of Science in Information Resources Management

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Preface

The purpose of this study was to conduct an experiment that tested the effect of non-zero starts and scale breaks with the dependent Y axis for bar graphs, on the outcomes of actual decision making. The need for this experiment was in response to the increased usage of bar graphs for making important decisions throughout the Department of Defense. Additionally, this thesis completes a study started two theses ago on the effects of non-zero starts and scale breaks used in bar graphs in conjunction with the adoption of high integrity graphing standards.

Over 180 subjects completed the experiment. Decisions were made based on bar graphs that displayed the data in a normal format (starting from zero), or with non-zero starts, or scale breaks. Additionally, data were displayed using a tabular format. The results display a significant difference between standard graphs and those depicting non-zero starts. Limited differences existed between standard graphs, tabular data, and graphs with scale breaks. Study of this subject should be continued, as it could be of great value for decision makers.

In performing the experimentation and writing of this thesis, we have had a great deal of help from others. We are deeply indebted to our faculty advisors, Maj David S. Christensen and Dr. R. Antolini, for their continued patience and assistance. Additionally, we wish to thank our fellow students for participating in the experiment. Finally, we wish to thank our families for their understanding and concern for those many long nights and weeks tied to our computers and the library.

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Abstract

This thesis investigated whether a difference in data display modes or differences in data trends affected mid-level Air Force managers trend impression, risk assessment, and loan decision. A literature review revealed several criteria for constructing high integrity graphs and that when certain criteria were violated, viewers could be misled as to their assessment of the underlying data. By presenting data in four different modes, and by three data trends, a 4 x 3 factorial design experiment was prepared. 180 subjects were tested, 15 in each of the 12 treatment cells. Each subject viewed 3 graphs or tables, made a decision based on the trend observed, their assessment of the trend, and a decision table. At the end of the experiment, the subjects were asked for their impression of the trend and their assessment of the risk involved in each of the three data sets. The subjects also completed a demographic questionnaire. Using an automated statistical analysis package, a multi-factor analysis of variance was conducted. It was shown that the mode of presentation did have an affect on the subjects loan decisions and trend interpretation and risk impression. Trend type was also a significant factor in each response category. A one-way analysis of variance was conducted on the demographic data for each area. It was found that age, gender, area of expertise, and graphics training were significant factors in some response areas.

THE EFFECTS OF VIOLATIONS OF BAR CHART STANDARDS ON MANAGERIAL DECISION MAKING

I. Introduction

General Issue

The economy is in recession, the military budget is being reduced, the size of the active duty force is shrinking, and everyone is expected to do more with less. Military leaders and managers at all levels of the Air Force face serious challenges ahead; answers to where and how to spend the budget are becoming increasingly more difficult.

As decisions are made in volatile environments, graphs provide a means of summarizing reams of data into a single meaningful picture. An old Chinese proverb says that a picture paints a thousand words. While this is true when the picture is painted without artist impressions, problems can arise when the artist uses his artistic liberties. The same could be true with graphs if the person constructing the graph exercises artistic judgment. In order for leaders and managers to make appropriate decisions, the graphs that are used to paint the picture must accurately depict the data they represent.

Several recent studies have noted that misleading graphs were used in the annual reports of many top corporations in America. A 1988 study found that discrepant graphs occurred more frequently in annual reports of companies which experienced a decline in net income. In most cases, the faulty graphs portrayed data in a more favorable light than

warranted (Steinbart, 1988:69). The potential for this same type of abuse is also possible within the Air Force, especially in areas where the Air Force must deal with contractors and suppliers.

There are numerous standards that suggest how graphs should be constructed to best represent data. Several authors have stated that graphs should begin from the zero point on the dependent axis (Auger, 1979; Tufte, 1983; Taylor, 1983; Schmid, 1983; Steinbart, 1988; and others.) Three authors recommend that the dependent axis (data) not contain a scale break (Auger, 1979; Cleveland, 1985; and Carvalho and McMillan, 1992.) These authors argue that violations of these standards distort the data in a manner that can lead to false impressions and misinterpretations of the data contained in the graphs.

Two recent AFIT theses have tested some of these points. In 1991, Kern experimented with high-integrity graph standards involving Tutfe's "Lie Factor" as a way of measuring distortion in graphs. He found that Air Force decision makers could be misled by positive and negative trends when graphs were constructed improperly using a non-zero starting point on the dependent or "Y" axis.

In a later experiment, Carvalho and McMillan tested the effects of scale breaks on the dependent "Y" axis with a graph that starts at zero. Their results indicated that when graphs violated the standards by using a scale break, the subjects tested formed erroneous impressions of the data. All of these prior theses and experiments made a correlation to impressions rather than to the actual outcomes of decisions being made while viewing the graphs.

Specific Problem

This thesis goes one step further. It attempts to determine if there is any correlation between improperly constructed graphs drawn using a non-zero axis and outcomes of decisions made by AF subjects. Thus, can graphs that are constructed in violation of these high-integrity graph standards mislead Air Force mid-level decision makers? The specific hypothesis to be tested is:

Null Hypothesis: There is no statistically significant difference in decisions made based on any of the following four presentation methods:

a. Tabular data

b. Bar graphs that include the zero point on the dependent ("Y") axis

c. Bar graphs that include a scale break on the dependent ("Y") axis

d. Bar graphs that start from a non-zero point on the dependent ("Y") axis

Investigative Questions

To adequately test the hypothesis, the following investigative questions are relevant and will be addressed:

1. What are the standards for high-integrity bar graphs?

2. What previous studies have been conducted in the area of graphical representation of data?

3. Are any of the standards for high-integrity graphing methods of any significance to Air Force decision makers?

4. Are there any key government decision making programs that rely on graphs?

5. Are there any existing military standards or Air Force standards for the construction of graphs used by Air Force decision makers?

6. What are the existing standards involving scale breaks of the vertical axis and for starting the vertical axis at a non-zero point?

7. Can graphs constructed in violation of Tufte's Lie Factor (those that have a Lie Factor greater than 1.0 give a false impression of the data they represent?

8. Can graphs constructed in violation of the standard for scale breaks be misinterpreted?

9. Can graphs constructed in violation of the standard for starting at the zero-base line on the vertical axis be misinterpreted?

10. Are there any demographic factors which affect a subjects' ability to interpret graphs constructed with scale breaks or constructed with a vertical axis that does not begin at zero?

11. Can graphs that give false impressions of the data they represent or that are misinterpreted have an impact on the decision an Air Force decision maker makes?

Limitations

There are several limitations to this study which reduce its scope and warrant discussion. First, the experiment was designed to be

administered in 15 to 20 minutes; this allowed the subjects approximately one minute to view each graph, form an impression, and make a decision. The subjects were given an experiment package made up of an example graph, three test graphs or tables, and a questionnaire. After the sample graph or table was presented and explained, subjects were then asked to make a decision based on what they observed in the three test graphs or tables contained in their individual experiment packages.

While it is not unreasonable for decision makers to spend less than one minute interpreting graphs and forming opinions, the task was simplified by asking the subject to determine the amount of a loan based on the trend they observed and their impression of the significance of the trend. The graphs or tables contained in the experiment packages depicted increasing, decreasing, or fluctuating net assets for a fictitious company.

Second, the experiment was limited to two types of data presentation forms. Vertical bar charts and tables were selected because the decision makers were more likely to have used these two modes of data presentations to assess trends for situations that occurred in prior job positions.

Third, the experiment was conducted in a sterile classroom setting. This controlled setting may not adequately simulate the stress and pressures of managerial decision making. Other limitations relating to the experiment design are discussed in Chapter 3, Methodology.

Conclusion

Investigative questions 1 to 7. along with other research material pertinent to this study, are discussed in Chapter 2, Literature Review. Chapter 3, Methodology, discusses the construction, administration, and statistical manipulations/analyses needed to answer investigative questions 8 to 11. This section will also address the limitations of the experiment design and administration. Chapter 4, Analysis and Findings, contains the results obtained from the experiment related to investigative questions 8 to 11. The final chapter, Chapter 5, Conclusions, contains a summary of the study, an interpretation of the results, and recommendations for further research.

II. Literature Review

Introduction

This chapter provides the necessary background for understanding the importance of high-integrity graph construction, and for understanding how improperly constructed graphs have resulted in misinterpretation of the data the graphs represent. It is divided into two major sections: (1) background on graph usage and high-integrity graph standards, and (2) key government decision making programs.

Section 1 reviews the uses of graphs, the history of graph standards, the validity of graph standards, the causes of misleading graphs, and corrections to the problem of misleading graphs. Section 2 gives a brief synopsis of two key government decision making programs that rely on graphs in the decision-making process. The programs are known as Corporate Information Management (CIM) and business-process reengineering.

Background on Graph Usage and Graph Standards

Pictures or graphics as they are more commonly referred to now, have been an integral part of human existence. Through the use of pictures or graphics, languages have evolved into what we use to communicate today. Early man used pictures to communicate thoughts, ideas, or even problems. We use graphics and pictorial representations today to portray the same basic idea of communication. In fact, many times when words fail us, we resort to using a picture or graphic representation of data to clarify the words we want to use.

Uses of Graphs. Before a discussion is started on standards for high integrity graphs, it is important to first know why graphs are used. The question is legitimate and there are several answers.

First, a graph is an excellent method of summarizing large amounts of data. In the late 1700's, William Playfair described a systematic method of presenting large amounts of social and economic data in graphical form (Cox, 1978:5). Many authors and users are of the opinion that graphs are useful in everyday operations. A management consultant for McGladrey, Hendrickson and Pullen in Indianapolis Indiana, Rob Schlegel, stated that graphs turn data into information that results in spotting trends, percentages, and ratios not easily apparent beforehand (Schlegel, 1986:37). Graphs can also clarify complex or hazy points, and can help pinpoint relationships that would be overlooked if the data were in tabular form (Reichard, 72:46-47).

For many reasons, graphs are usually able to communicate ideas better than textual or tabular data. According to Steven Pollack, senior product manager at Claris Corporation (Santa Clara, California) "graphically presented ideas are comprehended more quickly and retained better than textually presented ideas" (Panchak, 1990:63). In fact, empirically derived statistics demonstrate two points. First, audiences remember only 20% of what they hear but a "whopping 80% of what they see." Second, in a study conducted by the University of Minnesota, presentations that utilized graphics were more than 40 percent more effective than those that didn't (Barron, 1990:32).

Another reason for including graphs in reports and briefings is that they tend to add credibility to the presentation. A recent

empirical study found that in today's computer age, presentations which incorporated graphs were more effective than those that did not. Because they present information in a more concise manner than other forms of presentation, they tend to "impress the reader" (Johnson, 1980:51-52). A side benefit of this is that presenters using visual aids are perceived as significantly better prepared, more professional, more credible, and more interesting than those who had no graphics (Barron, 1990:32).

Although there are many valid reasons for using graphics, there are also pitfalls. Almost every author that lauds the benefits of graphic presentations also adds a bit of scepticism. Their concerns are valid. According to one author:

> Graphics are appearing more regularly within the management hierarchy for the purpose of serving as decision tools. Yet preliminary evidence suggests that a picture may not be worth a thousand words--or even a thousand numbers. Given the dollars that organizations do and will spend on computer graphics, there should be more effort to understand the role of graphics in the decision-making process. (DeSanctis, 1984:482)

DeSanctis further states that the basic thrust should be to design graphs that can be quickly read and accurately interpreted; graphs which facilitate quality decision making.

Others have expressed concerns, too. Steinbart aptly stated that "when properly constructed, graphs highlight and clarify significant trends in the data. Improperly constructed graphs, on the other hand, distort the trends and can mislead the reader. Even sophisticated readers can be misled" (Steinbart, 1988:60).

How did this problem arise? and How can it be solved? Before answering these questions, it is important to take a look at the history of graphical standards and to also take a quick look at some research in the area of high-integrity graphs.

History of Graph Standards. Development of graphical methods began as early as the mid 1300's when Oresme presented his ideas on graphing functions. These thoughts were fostered and developed through the next 500 years. In the "late 1800's graph paper became common and the 'Golden Age' of graphical techniques ensued" (Cox, 1978:5). During this time it became evident that some form of graph standardization was needed in the science of statistical graphs.

In 1915, The Joint Committee on Standards for Graphic Representation (hereafter called the Joint Committee) published an article in the Journal of the American Statistical Society that stated:

> If simple and convenient standards can be found and made generally known, there will be possibly a more universal use of graphic methods with a consequent gain to mankind because of the greater speed and accuracy with which complex information may be imparted and interpreted. (Joint Committee on Standards for Graphic Representation, 1915:91)

This was the first attempt to define standards for graphical integrity.

In its simplest form, the most generalized standard is that a good graphic should highlight key information, focus on one clear idea, be simple and accurate, be bold, informative, and easy to read (Barron, 1990:32). However, this standard can be ambiguous because it does not define the term "accurate," nor does it quantify the term "informative".

Many others have defined specific standards that are less open to interpretation. For instance, the Joint Committee defined 17 such

standards. They ranged from stating that the arrangement of a graph should proceed from left to right, to recommending that the zero line should be shown by the use of a horizontal break in the graph when the zero line of the vertical scale will not appear on the graph (Joint Committee on Standards for Graphical Representation, 1915:91-93). Their standards were specific.

Likewise, at least eight other authors have recommended a total of three dozen different standards. Although most of the authors of the standards are in agreement, there are some isolated instances where they hold opposing views. For instance, most authors agree with Jaffe that graphs should show the zero base line on the vertical axis to avoid data misrepresentation (Jaffe, 1987:15). Cleveland, on the other hand, stated "**DO NOT**" insist that zero always be included on the vertical axis (Cleveland, 1985, 101). His rationale is that including zero on the dependent axis could reduce the resolution of the information that the data portrays, leading to a meaningless graph (Cleveland, 1985, 79). He further argues that a critical reader will analyze the vertical scale markings and reach an appropriate conclusion.

See Table 1 below for the standards and authors who support or disagree with non-zero starts and scale breaks. The table is a careful extraction of those portrayed and listed by Larkin (1991) and Carvalho and McMillan (1992) in their theses. The table only lists the standards dealing with non-zero starts and scale breaks. An author's agreement with a particular criterion is indicated with an "X", while disagreement is marked with an "O". The cross-referenced listing of authors and the year in which they stated their views follows directly after the table.

TABLE 1

Criteria for Constructing High Integrity Graphics Using

Non-Zero Starts and Scale Breaks, Cross Referenced by Author

CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Charts with a arithmetic scale should begin at the zero base line.	X	X		X	X	X	X	X	X	X	X	X	X	O	X	X
2. Scale breaks should be used for false origins.				X	X							X				
3. Avoid broken scales which give inaccurate impressions.				X						X		X		X		X
CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

<u>Author</u>		<u>Year</u>
1.	Tufte	1983
2.	Taylor	1983
3.	Larkin	1990
4.	Schmid and Schmid	1954
5.	Joint Committee on Standards for Graphic Representation	1915
6.	MacGregor	1979
7.	Steinbart	1986
8.	Johnson, Rice, and Roomich	1980
9.	Spear	1969
10.	Auger	1979
11.	Rogers	1961
12.	American Society of Mechanical Engineers	1979
13.	Lefferts	1981
14.	Cleveland	1985
15.	Schmid	1983
16.	Carvalho and McMillan	1992

One of the major drawbacks with the graphical standards is that relatively few have been empirically tested. "Although the use and study of graphics is of interest to many disciplines such as statistics and management, graphics research has not had many studies conducted to support some of the theory" (Tan, 1990:416-417). Others, such as Taylor in her 1983 dissertation, recommend further study in the area of graphic formatting (Taylor, 1983:127). Toward this end, four recent studies have made progress in validating or invalidating a portion of this group of standards.

Validity of Graph Standards. The primary research consists of a doctoral dissertation by Barbara Taylor, a student at Texas Tech University in 1983; and three Air Force Institute of Technology (AFIT) theses; one by Larkin in 1990, another by Kern in 1991, and the third by Carvahlo and McMillan in 1992. Additionally, there are two other AFIT theses underway.

Taylor's research was in the area of accounting. Part of her experiment was to test eight of the graphic standards to see if loan officers at financial institutions could be misled when graphs were constructed in violation to the standards (Taylor, 1983:12-13). Her experiment yielded statistically significant results to support seven of the eight graphical standards. They are as follows:

> 1. Rate of change charts (semilogarithmic) should not be used for public presentation.
>
> 2. Discretionary selection of years to be presented may affect viewer's perceptions.
>
> 3. Multiple-amount scales should be used with caution or misrepresentation is likely to occur.

> 4. The financial statement order of presenting time beginning with the latest period on the left and ending with the earliest period on the right for the horizontal scale may create a different illusion of company performance.
>
> 5. The omission of zero on the vertical scale magnifies the changes and may make unimportant changes seem important.
>
> 6. Stratum exhibiting marked irregularities should be placed at or near the top of the graph.
>
> 7. Don't extend the scale range very much beyond the highest or lowest point unless you are sure the results will be a more realistic picture.
>
> 8. Contracting or expanding either or both the vertical and horizontal scales radically alters the configuration of curves thus conveying different visual impressions. (Taylor, 1983: 67-68, 79-80)

Her experiment validated the first seven standards/hypotheses, but failed to support the eighth.

Larkin's research focus was to either prove or disprove the validity of six graphic standards in relation to whether or not the violations would mislead Air Force decision makers. Larkin found that decision makers formed false impressions when graphs were constructed in violation of the following criteria were:

> 1. The more irregular strata (stratum with the least variability) should be placed near the bottom of the graph.
>
> 2. Labels should be used to defeat graphica. distortion and ambiguity. (Larkins subjects were misled by mislabeling graph quadrants).
>
> 3. The horizontal axis (scale) should usually be read from left to right; vertical scale from bottom to top.
>
> 4. Linear quantities should not be represented as areas or volumes.

5. The general arrangement of the graph should be proceed from left to right. (Larkin, 1990:36-37)

A sixth criterion that Larkin tested was found not to be statistically significant. In those graphs, Larkin switched the X (independent) and Y (dependent) axes (Larkin, 1990:56-57).

Kern's research focused on a single criterion of graphical integrity called Tufte's "Lie Factor". Tufte's "lie factor" is one way of measuring distortion in graphs. Tufte stated that "the representation of numbers as physically measured on the surface of the graph itself, should be directly proportional to the numerical quantities represented" (Tufte, 1983:56). Tufte designed the following formula to measure the amount of distortion in a graph:

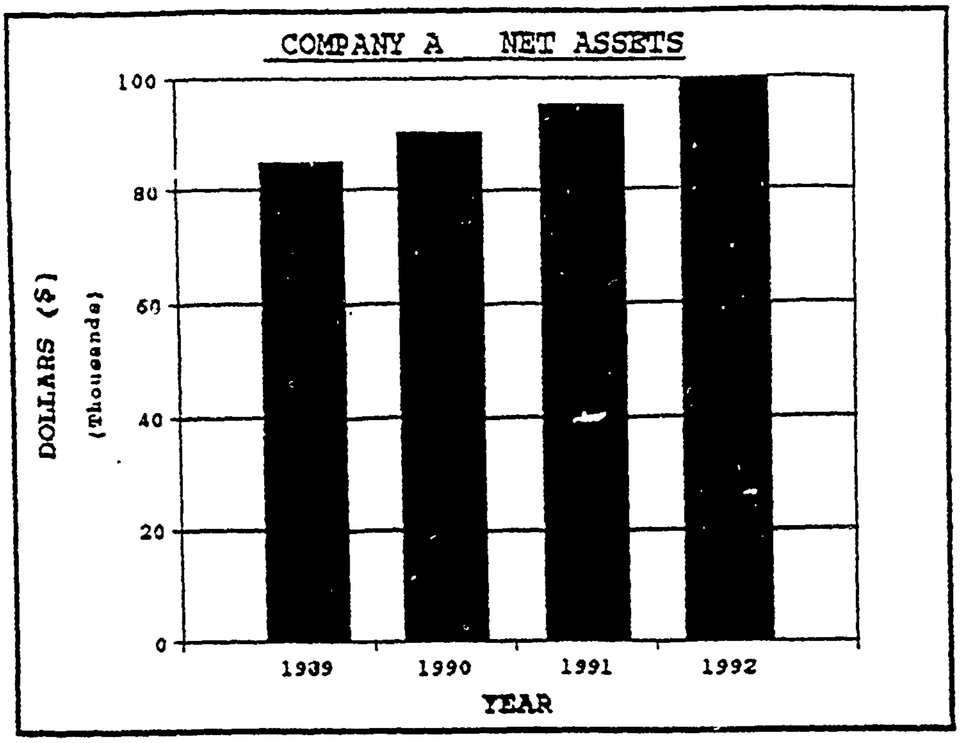
$$\text{Lie Factor} = \frac{\text{Size of Effect Shown in Graphic}}{\text{Size of Effect in Data}} \qquad (1)$$

According to Tufte,

> If the lie factor is equal to one, then the graphic might be doing a reasonable job of accurately representing the underlying numbers. Lie factors greater than 1.05 or less than .95 indicate a substantial distortion, far beyond minor discrepancies in plotting. (Tufte, 1983:57)

Violating other high-integrity criteria such as starting the Y (dependent) axis from a point other than zero will lead to a lie factor larger or smaller than 1.0. This point is illustrated in Figure 1.

In his experiment to prove/disprove the validity of Tufte's "lie factor," Kern distorted graphs by failing to include a zero base point of reference on the vertical axis. Kern proved that "decision makers can be misled by positive and negative trend graphs formulated in



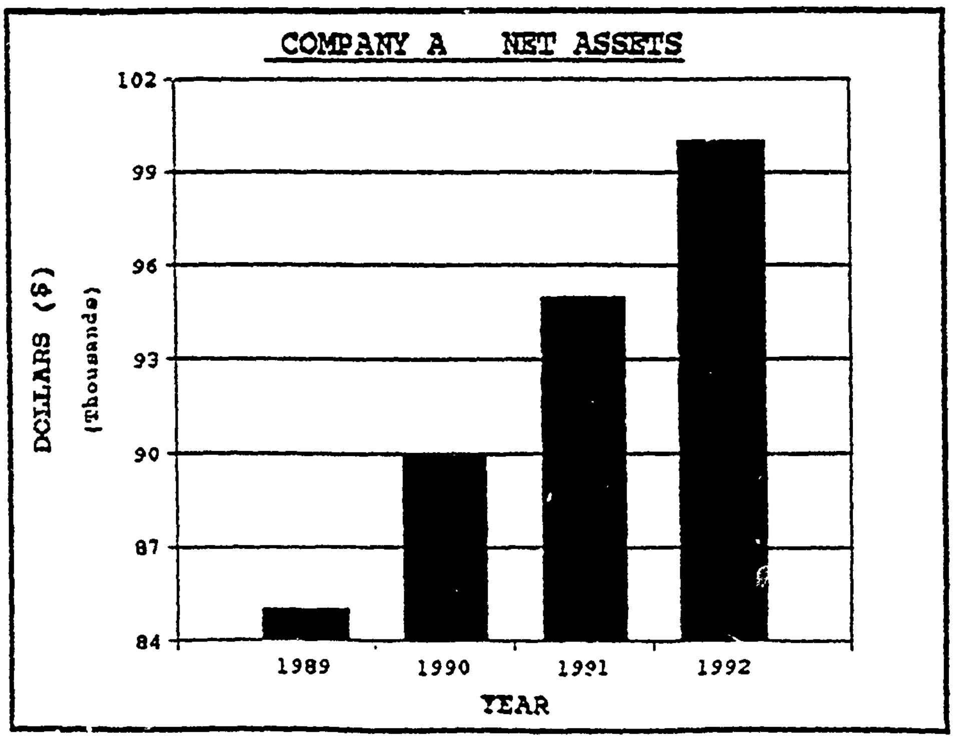


Figure 1. Visual Effect of Bar Graph Drawn From Non-Zero Point on Y Axis

violation of Tufte's criteria for lie factor" (Kern 1991:39). Although Kern achieved success in this area, he was not able to make any "conclusion concerning the degree to which different magnitudes of lie factors are misleading" (Kern, 1991:43).

Carvalho and McMillan took Kern's work one step further by studying the effects of a dependent axis scale break on a decision maker's interpretation of the data. They used control graphs that demonstrated no scale breaks, followed by experimental graphs that did contain scale breaks. At the same time, all of the control graphs were created using lie factors ranging from .949 to 1.04 (Carvalho & McMillan, 1992: 27-28).

Additionally, the lie factors were manipulated in their experimental postest graphs, with three graphs displaying dramatic scale breaks and three with non-dramatic scale breaks. This provided two distinct levels of visual distortion for the experimental posttest graphs. Carvalho and McMillan showed that there was a correlation between faulty graphs and misinterpretation of the data at the .95 percent confidence level (Carvalho & McMillan, 1992: 30). Figure 2 illustrates the effects of a scale break on the representation of data and also the effect on the calculation of Tufte's lie factor.

Although some research has been conducted to establish the validity of high-integrity graphical standards, there are at least 18 (including additions to those recommended by the Joint Committee by more recent authors) that warrant further study. In spite of the fact that many of the standards haven't been empirically proven, most make good sense. Yet several studies have shown that the propensity to violate the

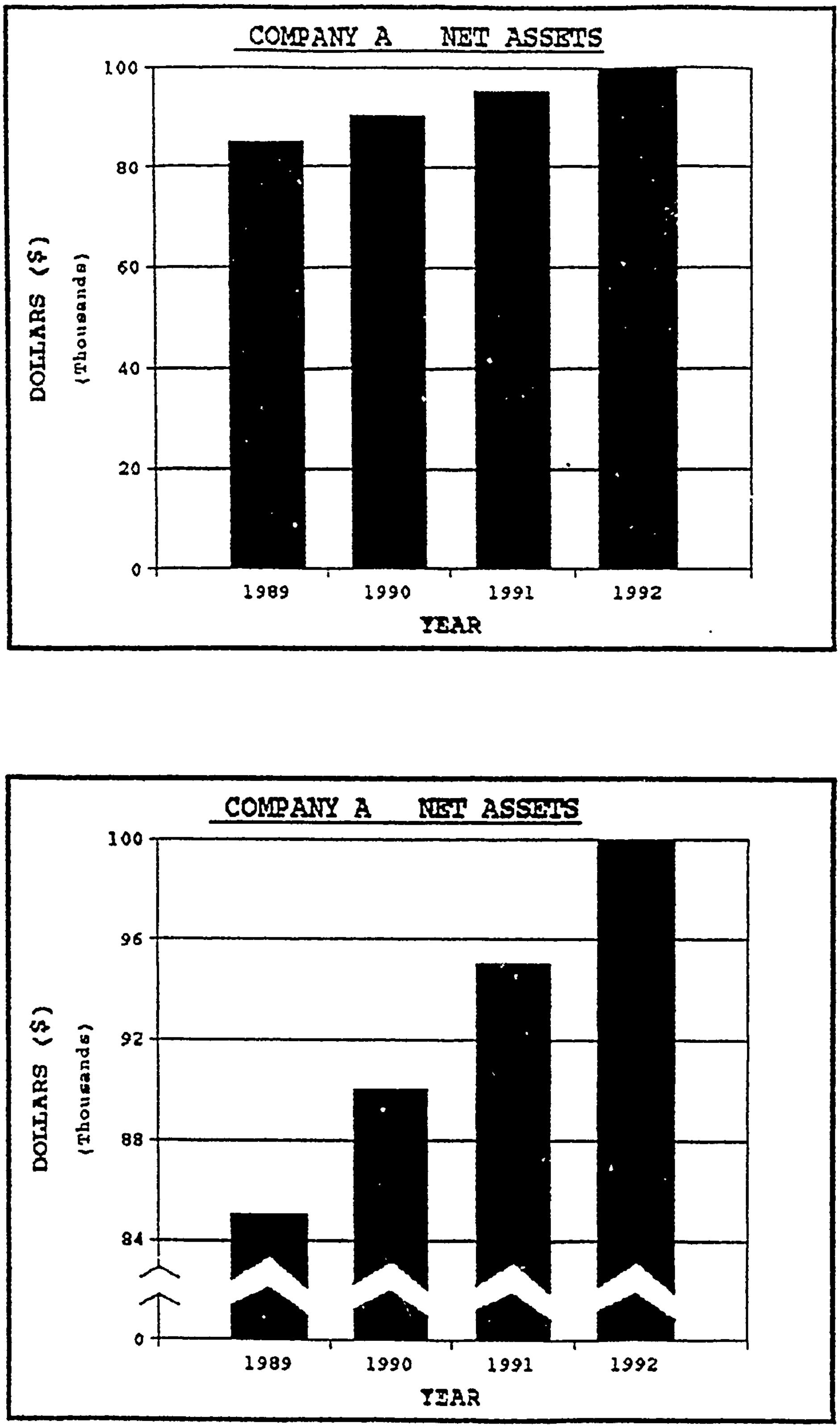


Figure 2. Comparison of Bar Graph Drawn With and Without Scale Break

standards is very high. Two studies, one by Johnson in 1980, and another by Steinbart in 1989 reflect this point. Johnson conducted a study to determine whether graphs in annual reports of Fortune 500 companies were misleading. Fifty reports were examined, covering the years 1977 and 1978. "21 reports or 42.0% contained at least one graph that was constructed improperlv. In total, 125 of the 423 graphs examined (or 29.5%) were constructed incorrectly" (Johnson, 1980:52).

In Steinbart's study of 319 Fortune 500 companies in 1986, the following observations were made:

> 1. Of the 202 companies that experienced increases in net income, 150 of them (74%) included graphs.
>
> 2. Of the 117 companies that experienced decreases in net income, 62 of them (53%) included graphs in their annual reports.
>
> 3. The difference in percentages is statistically significant. Companies with "good news were more likely to include graphs than were companies that reported "bad" news. (Steinbart, 1988:63)

In contrast to Johnson's study; Steinbart found most of the annual financial reports contained graphs that were properly designed. Only eight percent of the annual reports that were examined contained a graph that presented data in a manner likely to create a significantly more favorable impression of corporate performance than was warranted by the information in the financial statements (Steinbart, 1988:69).

In both studies, the majority of misleading graphs overemphasized recent upward trends and de-emphasized downward trends. There are two possibilities for this phenomenon. First, the faulty graphs could have been unintentional, the graph maker may have been ignorant of the

standards for high-integrity graphs. Second, the graphs were intentionally designed to be misleading. In Johnson's study there were some examples that indicated the possibility of this being true. For example, one report had two graphs that appeared side by side. One was constructed correctly, the other incorrectly (Johnson, 1980:55).

As was stated earlier, graphs can be used to show data structure, show trends, clarify points, and aid decision makers. This assumes that the principles for graph construction are followed. "These principles are relevant for both data analysis when the analyst wants to study the data, and for data communication when the analyst wants to present quantitative information to others" (Cleveland, 1985:21).

"It is safe to say that no statistical tool is used more often to deceive the unwary than the statistical chart" (Campbell, 1974:45). This leads to the questions posed earlier; How did the problem with misleading graphs arise? and How can the problem be solved?

Causes of Misleading Graphs. There are a number of reasons why principles are not followed, resulting in misleading graphs: the untrained graph maker, the untrained graph reader, time constraints, the lack of controls in computer graphics software, and the unscrupulous graph maker.

Unawareness of graphical standards can be a hindrance to both the graph maker and the graph reader. A graph maker may unintentionally distort data by violating one of the graphical standards. The possibility does exist that an untrained graph reader may be unable to determine that a graph is misrepresenting data (due to the way a graph is formed) and may inadvertently cause a faulty decision to be made.

Another factor involved with the interpretation of graphs is that of time constraints. "With executive time in short supply, pictures or graphic presentations are a virtual must. Information must be summarized instantaneously and ideas presented more quickly and clearly" (Reichard, 1972:46). Regardless of whether the misleading graph was intentional or not, a lack of viewing time can prevent the decision maker from comparing the graphs to the tabular or textual data. The decision will be based on the graph and may result in a faulty decision.

Recent advances in computer technology have become the catalyst for the use of graphics in reports and presentations (Taylor, 1983:115). DeSanctis alludes to the lack of software controls in computer programs that generate graphics (DeSanctis, 1984:463). Tan emphasizes the need for not only software controls but also the need for a program to train graphics designers (Tan, 1990:417). Lack of internal software controls or user training may inadvertently allow graph makers to format graphs that violate one or more standards for high-integrity graphs.

Although part of the problem results from an ignorance of high-integrity graph standards on the part of the graph designer, many feel that the major part of the problem in the area of misleading graphs comes from those who intentionally "misrepresent" data. Misrepresentation is the distortion of the data through the manipulation of graphic formatting (Taylor, 1983:31). This is differentiated from "numerical inconsistency" in which points on a graph are not accurately plotted and differ from the tabular or textual data.

In his 1988 study, Steinbart felt graphs were intentionally faulty because 24 of 26 reports that contained improper graphs also contained

properly constructed graphs (Steinbart, 1988:68). He further stated that:

> Of the 150 companies experiencing increases in net income (and that also included graphs in their annual reports) 9.3 percent had discrepant graphs. All portrayed data in a more favorable light than warranted. Of the 62 companies that experienced decreases in net income (and also included graphs), 19.4 percent portrayed the data in a more favorable light than warranted. The difference is statistically significant. **Discrepant graphs are more likely to occur in annual reports for companies which experience a decline in net income** (emphasis added). (Steinbart, 1988:69)

Taylor and Johnson also noted similar results in their studies. Both noted that misleading graphs overemphasized recent trends through manipulations in the graphic formatting. Most reports that contained misleading graphs also contained graphs that were constructed properly. This gives the impression that management may have had ulterior motives in presenting misleading graphs (Taylor 1983:23; Johnson, 1980:55). What can be done about all of this? There are at least three viable alternatives.

Correcting the Problem of Misleading Graphs. One of the first steps that should be taken is to educate and train both makers and readers of graphs. Because of the proliferation of personal computers and graphics packages, it is time to train graphics designers and end-users on how to construct high-integrity graphs (Tan, 1990:417). Tan assumes that if training were to be conducted, then it would reduce misrepresentation of data through graphs and the use of inappropriate graphical formats (Tan, 1990:417).

One might argue against Tan's statement that training might give even more people ideas about how to misrepresent data. However, Huff

quells this notion by saying that "the crooks already know these tricks; honest men must learn them in self-defense" (Huff, 1954:9).

Another avenue of approach would be to create rules (regulate) graph construction. Organizations such as the Financial Accounting Standards Board (FASB) could incorporate graph standards into their domain. The government could also create guidelines for internal use and for dealing with contractors that seek to do business with them. Many offices as well as auditors in the government and in the accounting business would be the first affected, if some type of guidelines or rules were to be enacted for graph construction.

In the same vein as regulation, software packages could be redesigned to include high-integrity graph standards. These software controls should be designed to prevent users from knowingly or unknowingly creating misleading graphs. Before a recommendation can be made though, more research is needed.

First and foremost, all of the remaining standards should be empirically proven or disproven. This would give supporting evidence for any future rules or standards adoption by the government or the Department of Defense.

Second, the impact to real world scenarios must be determined either through further empirical studies or a governmental evaluation to see if the problem is big enough to warrant widespread regulation or new software design. If the problem of misleading graphs is so widespread or has caused faulty decisions of a large magnitude, then some or all of the solutions mentioned above must be implemented.

Although many of the studies mentioned previously have shown with a high degree of confidence that distorted or poorly constructed graphs can mislead and give people false impressions; none have shown that the false impressions lead to any difference in the outcome for any particular decision made using faulty graphs. It is possible that even though a decision maker was misled in their interpretation of the data, they may have made mental compensations for that prior to the decision being made. The question remains whether or not faulty graphs have any significant effect on a person's decision.

In order to give the reader a solid knowledge base, this section covered the background behind graphical standards. It discussed why graphs are used, the history of graph standards, recent research of the elements of graph integrity, how the problem of misleading graphs arises, and some solutions to those problems. The next section will review two key government decision making programs that rely on graphs in the decision-making process.

Key Government Decision Making Programs.

Key decisions are being made at all levels of government on a constant basis. These decisions may involve the use of graphs to make an informed decision. Additionally, these decisions may involve allocating resources or actual money that may amount to millions of dollars.

Background. Today's dynamic military environment dictates the need for quick and reliable information. With the explosion of technology today, many people are often overwhelmed by the new gadgets, computers,

and programs that are widely available. For those individuals who must rely on computers and computer products to make crucial decisions, there are times when one may not be sure that those products are telling the truth.

There are several programs that the government is using to aid decision makers in their job of cutting government spending. The first is Corporate Information Management or CIM, and the second is called business-process reengineering. Both programs are heralded as the best way to trim government waste while still completing the mission or job at hand.

CIM. Corporate Information Management is a "broad Defense Department program that will attempt to improve military management techniques through better application of information technology" (Corbin, 1992:36). This program is expected to help trim defense waste and overspending while helping to trim bureaucratic red tape and paperwork.

CIM is also a part of the Defense Management Review (DMR) program from which Defense Management Review Decision (DMRD) #998, Centralized Defense Department Printing, evolved. "The pentagon is counting on the DMR initiatives to save a total of $70 billion in spending by fiscal 1997, fully half of which is to be achieved through CIM" (Corbin, 1992:36). DMRD #998 provided an example where hidden costs, faulty graph construction, misrepresented data, and improper data comparisons undermined a decision to consolidate Defense Department printing under one military service.

With DMRD #998, all three services listed their cost-per-thousand for their respective duplicating centers. The Navy won the option by only listing it's land based facilities which brought it's costs in well under those graphed by the Army and Air Force. By omitting their shipboard costs, the Navy's graph looked more favorable compared to those submitted by the other two services. None of the key decision makers knew enough about the Navy's operations to understand that they were seeing only half of the equation. The misleading graphs went unchallenged until after the decision was made and the process of conversion was too far along to stop (DoD DMRD #998, 1991:1-8).

The possibility exists that the managers of the CIM program could avoid the problems with faulty graphical information and principles, which transpired with DMRD 998, by adopting high integrity graphing principles and standards. These principles may allow for the proper usage of critical information for making the decisions that will point the government, and particularly, DOD towards the saving of taxpayer's dollars.

"CIM's applications extend to almost every aspect of Pentagon operations; functioning in the areas of payroll, personnel, contract payments, distribution centers, financial operations, material management and medical services" (Corbin, 1992:36). With this large impact on how the military does business, it may help to insure that the information used in the decision making process was correct.

__Business-Process Reengineering.__ Business-process reengineering is the "radical redesign of organizational structure, management systems, human-resource programs and tasks" (Corbin, 1992:41). The program is

being looked at by the government "in an effort to meet challenges brought on by budget and staff cutbacks" (Corbin, 1992:41).

Wherever the government tries to save money, high integrity graphs and principles could be easily considered and adopted. The dedicated use and support of high-integrity graphing standards may lead to improved representation of graphical information for many of the programs the government is now using or expects to use, to eliminate excess spending.

With the advent of so many computer systems, it is all too easy to produce key information that may have disastrous effects on our ability to actually save any money with future key decisions. Business-process reengineering may be just the right vehicle with which to introduce high integrity graphing standards to the federal sector.

Conclusion

During budget crisis situations, it pays to make the decisions using only the best possible correct information. Whatever program the Defense Department turns to must have a way of supplying high-integrity graphing methods and standards for the top decision makers.

The general public no longer seems to be willing to support the financing of decisions that are later declared bad, inept, or are based upon faulty reporting of critical data. Adopting and enforcing high-integrity graphing standards may provide the correct information in the future that could save money versus waste it.

The literature discussed shows that the presentation of critical data in graphical format has been a concern since the mid 1300's. As early as the late 1700's, William Playfair described a systematic method for presenting social and economic data. Graphs have been considered an excellent way to represent difficult data and relationships throughout the years.

Defining graphical standards and integrity have been more recent concerns. In 1915, the Joint Committee on Standards for Graphic Representation made the first attempt to identify proper ways to create graphs. Several other attempts have been made fairly recently to identify graphing standards. To date, some 36 different graphical standards have been suggested, of which, roughly half have been empirically tested. The research that has been conducted up to the present, both here at the Air Force Institute of Technology (AFIT) and elsewhere, shows that errors can occur both intentionally and unintentionally.

The correct or proper representation of graphs has a very real impact on how we interpret the underlying data. If a connection can be made between a faulty impression of the data due to an improperly constructed graph and a difference in that person's decision, then there is strong need for concern. With the constantly shrinking Defense Budget, faulty decisions that may be made due to graphical errors are becoming too expensive to excused by today's money conscious taxpayer.

The government is avidly searching for new ways to streamline and cut fiscal waste from many of it's defense programs. Using programs such as Corporate Information Management and Business-Process

Reengineering, the government hopes to achieve far-reaching spending reductions. This undertaking calls for serious consideration and use of high-integrity graphing principles and standards to help with the decision making process.

It has been proven repeatedly throughout history, that sound fiscal policies are based on carefully crafted standards and principles. The same should apply to the future, with high-integrity graphing standards and principles in place, to ensure that the fiscal decisions made will be based on reliable and correct data interpretation.

This literature review has answered the first seven investigative questions as well as providing some pertinent background information on all the key issues that are relevant to this particular research effort. Additionally, a starting point for future literature review endeavors was firmly established.

The importance of using high-integrity graphing standards in current government decision making situations was demonstrated. Both government and private sectors are relying more heavily on graphs for the specific purpose of making key decisions involving all types of resources. In addition, software programs are rapidly proliferating that allow the average user to represent numerical data graphically.

The increased use of these new graphical software packages does not necessarily mean that the graphs and information depicted have been constructed to avoid the possibility of erroneously representing the data through graphical manipulation. Therefore the problem of incorrect graphical formats and usage remains a constant threat to those people who must make key decisions using those graphs.

Faulty or incorrect graph construction was shown to be a detriment to key decision makers in one particular government program. Additionally, an in-depth look at previous research conducted in this area revealed that the business sector also suffers from the same problem. Investigation of previous research has revealed potential future impact on critical decisions due to improper graph construction. The actual issue of improper graph construction with respect to scale breaks, non-zero starts on the dependent ("Y") axis, and data tables used in direct correlation with actual decision making has not been investigated.

The standards which have been recommended from a variety of empirical studies and sources were listed in a tabular format. Further analysis of this table illustrated the fact that the scale break and non-zero start issues had not been positively linked to affecting the outcome of an actual decision. Previous empirical studies only displayed that improper construction or formatting of the graphs affected the opinions of those tested, not their actual decisions. Several of the authors listed in the table provided techniques for the creation of improper graphs and how to assess the impact a faulty graph may have on a decision using statistical formulas.

There are no existing Department of Defense standards or Air Force standards for the proper construction of graphs used in graphical presentations. Any standards or warnings that are included as part of a software program package used to construct graphs prepared for government presentations, appear to be the only standards or rules available to government employees.

The following chapter, Methodology, provides a detailed discussion of the experiment used to link the outcome of an actual decision to the improper construction of graphs using non-zero starts, scale breaks on the dependent "Y" axis, and tabular data. Chapter Four provides a detailed analysis of the findings of the experiment conducted and assumptions drawn based on the data obtained and answers the remaining investigative questions, 8 to 11. Chapter Five lists the results and recommendations for future research that may further support or negate the impact improperly constructed graphs have on decision making outcomes.

III. Methodology

There are numerous standards that suggest how graphs should be constructed to best represent data. This thesis is an extension of prior work conducted on misleading graphs involving Tufte's lie factor, scale breaks, and graphs starting from a non-zero base on the vertical axis (Kern, 1991; Carvalho & McMillan, 1992).

Area of Interest

The primary area of interest in this study is to determine whether decisions based on graphs constructed using a non-zero start, scale breaks, or tabular data are different from decisions based on graphs drawn with zero included on the dependent axis. Can graphs constructed in violation of previously outlined high-integrity graphing standards impact the outcome of decisions made by Air Force decision makers?

Approximately one-third of the estimated 36 high-integrity graph standards have been empirically tested or in some way studied in detail. The literature review revealed exactly which standards exist, which have been tested and which of the remaining standards are still untested. To provide a sound basis for the statistically tested hypothesis stated in Chapter 1, the following investigative questions had to be addressed:

1. What are the standards for high-integrity graphs?
2. What previous studies have been conducted in the area of graphical representation of data?
3. Are any of the standards for high-integrity graphing methods of any significance to Air Force decision makers?

4 Are there any key government decision making programs that rely on graphs?

5. Are there any existing military standards or Air Force standards for the construction of graphs?

6. What are the existing standards for scale breaks of the vertical axis and for starting the vertical axis at a non-zero point?

7. Can graphs constructed in violation of Tufte's Lie Factor (those that have a Lie Factor greater than 1) give a false impression of the data they represent?

8. Can graphs constructed in violation of the standard for scale breaks be misinterpreted?

9. Can graphs constructed in violation of the standard for starting at the zero-base line on the vertical axis be misinterpreted?

10. Are there any demographic factors which affect a subject's ability to interpret graphs constructed with scale breaks or constructed with a vertical axis that does not begin at zero?

11. Can graphs that give false impressions of the data they represent or that are misinterpreted have an impact on the decisions an Air Force decision maker makes?

Investigative questions 1 through 7 were answered in Chapter II, Literature Review. Investigative questions 8 through 11 will be covered using an experiment that was conducted with hard paper copies of computer generated graphics. Finally, the specifics of how the

experiment was designed, conducted, and analyzed are discussed throughout the following sections of this chapter.

Review of Literature Applicable to Methodology

The experiment conducted in this study provides the necessary link between Kern's research on the effects of Tufte's lie factor on graphical representation of data and Carvalho and McMillan's study of whether a scale break on the dependent (vertical) axis affects a decision maker's interpretation of data in graphical form.

Kern's research attempted to answer two specific investigative questions involving the use of Tufte's lie factor in the creation of graphs. The first asked if charts with a lie factor of greater than 1.05 or less than .95 could mislead decision makers. The second investigative question attempted to determine whether or not there was any correlation between the magnitude of the graph's lie factor and the level of misleading influence the graph possessed (Kern, 1991:6). Kern adjusted the scale of the dependent axis so that it would start at a point other than zero, (see Figures 3 and 4) thus creating experimental graphs with a lie factor greater than 1.05.

Carvalho and McMillan created the same lie factor effect but used a slightly different method. They generated graphs that started at zero on the dependent axis that also used scale breaks to modify the lie factor.

Kern's findings supported the results of an earlier study by Taylor. Both found that both positive and negative trend graphs with a lie factor outside the range of .95 to 1.05 were shown as misleading.

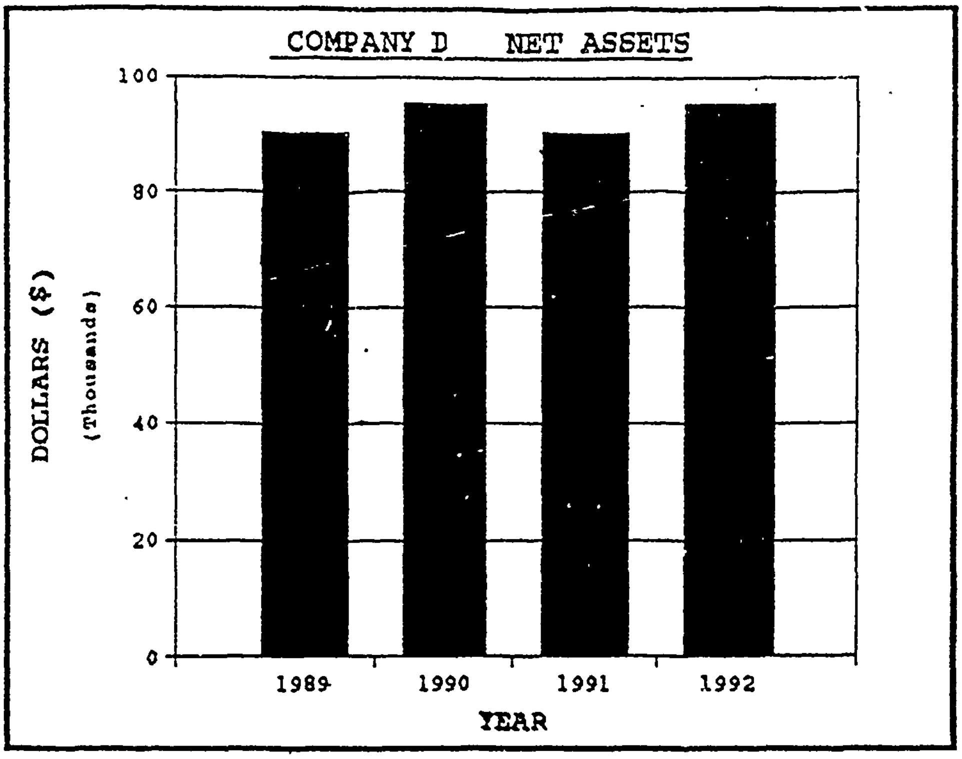


Figure 3. Graph Starting From Zero on The Dependent Y Axis For Comparison With Figure 4, From Kern's Thesis (1991).

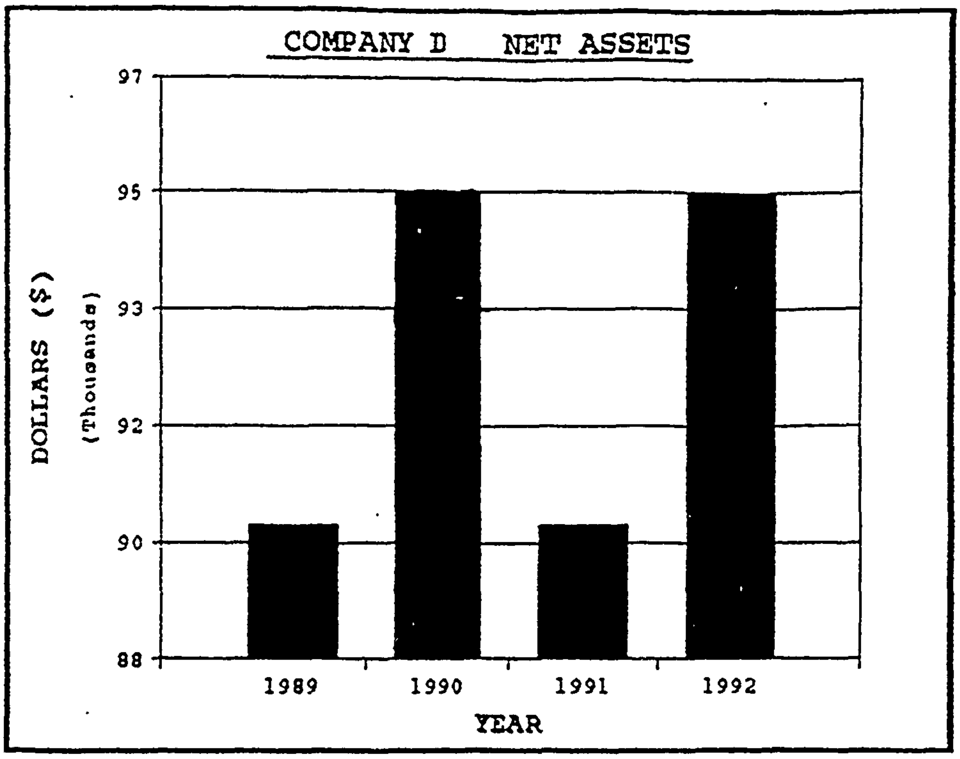


Figure 4. Graph Starting Other Than Zero on The Dependent Y Axis From Kern's Thesis (1991).

Although Kern was successful in demonstrating that improperly constructed graphs were misleading, he could not positively establish a correlation between the level of the lie factor and the degree to which a graph was misinterpreted (Kern, 1991:38-39).

Carvalho and McMillan experimented with another high-integrity graph standard. They used experimental graphs that contained a scale break on the dependent axis and control graphs that demonstrated no scale breaks. Both sets of graphs started from a zero base line on the vertical axis (see Figures 5 and 6). In addition to the scale break, Carvalho and McMillan used the lie factor as an independent variable.

All control graphs were created using lie factors ranging from .949 to 1.04; experimental graphs contained lie factors between 3 and 37 (Carvalho & McMillan, 1992· 27-28). The lie factors were manipulated in their experimental postest graphs, with three graphs displaying dramatic scale breaks and three with non-dramatic scale breaks. This provided two distinct levels of visual distortion for the experimental posttest graphs. Contrary to Kern's study, their research showed a correlation between high levels of misinterpretation and graphs with dramatic scale breaks. However, no threshold level was determined (Carvalho & McMillan, 1992: 30).

Both of the preceding studies used pretest-posttest experiments. Each demonstrated that the "impression" was significantly different between the nonstandard graphs with scale breaks or non-zero starts and the standard supported graphs without alterations. Each inferred that nonstandard graphs were misleading; however, neither study attempted to determine whether there was any impact on the subjects' decision.

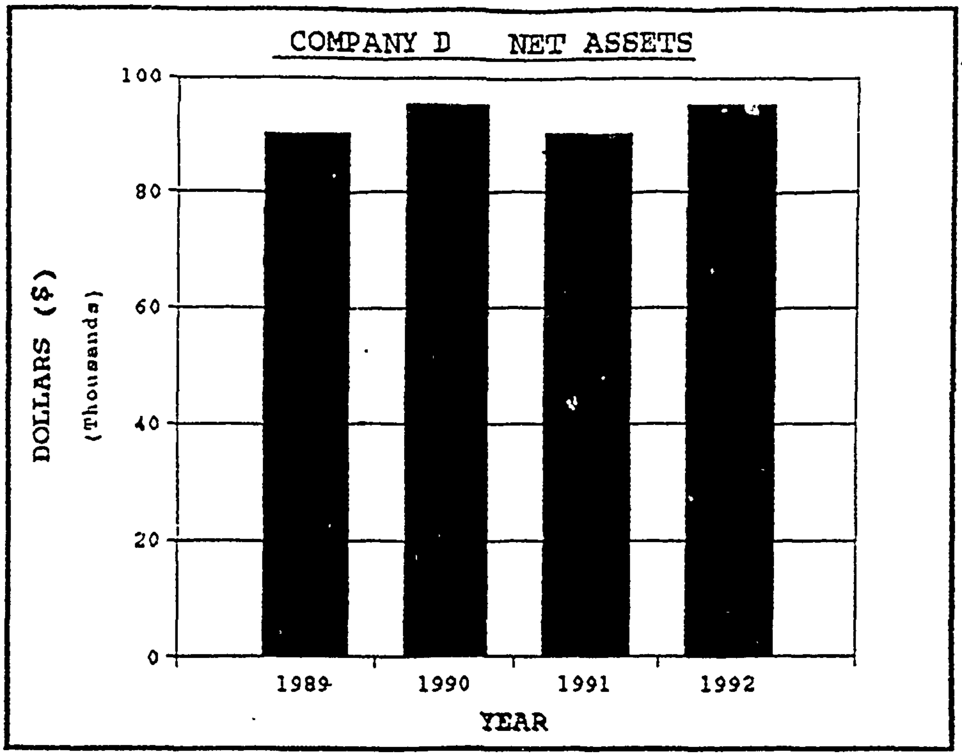


Figure 5. Graph Starting From Zero on The Dependent Y Axis For Comparison With Figure 6 From Carvalho and McMillan's Thesis (1992).

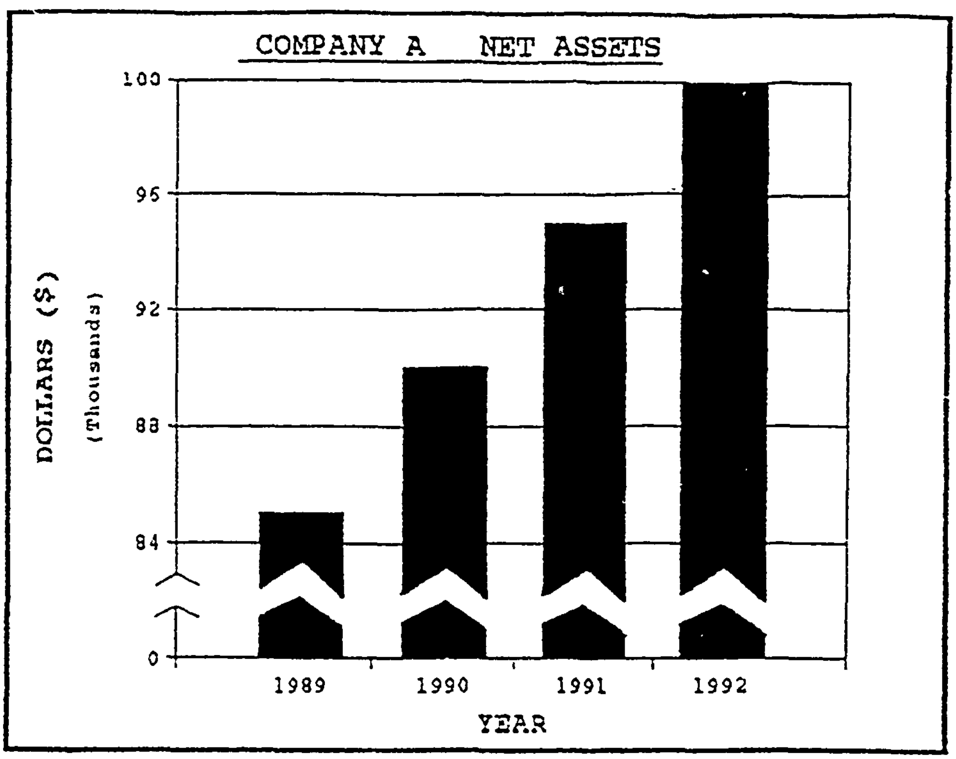


Figure 6. Graph Illustrating a Scale Break on The Dependent Y Axis From Carvalho and McMillan's Thesis (1992).

This thesis will provide a continuation of the two previous theses. This research used several sets of experimental graphs that were distorted by starting at a non-zero point on the vertical axis and by using scale breaks on the vertical axis.

Additionally, data listed in a tabular format was included in some of the experiment packages, providing an alternate means of portraying data rather than solely in a graphical format. This also added options for the researchers to observe if the same data portrayed in a table can confuse the subject or affect the outcome of the decision made.

Something that should be reiterated at this point, is that neither Kern nor Carvalho and McMillan tested for or established any correlation between graphs that were misleading and a subject's decision outcome. This thesis attempted to make such a correlation.

Additionally, this experiment design is a factorial design, rather than the pretest-posttest experiment used in the previous two theses. This experiment also compared and tested all three types of graphs, whereas the first two theses did not. Finally, a tabular presentation of the data was also compared, adding the fourth and final comparison or dimension to the experiment. None of the previous theses had looked at this particular form of data presentation.

For this experiment, each subject received a package containing instructions, an example graph or table, a series of three data sets presented in graphical or tabular format requiring a decision to be made on each, a short questionnaire concerning the subject's impression of the trends and the risk depicted by the data sets, and a demographic survey.

First, a scenario placed the subjects as loan officers about to make a loan from a bank to a fictitious local company (see Appendix B.) Each subject was instructed to view the graphs or tables contained in the package depicting the company's net assets for the past four years. The graphs or tables displayed either an increasing, decreasing, or fluctuating trend (see Appendix C.)

The subjects were then instructed that all loans were pre-approved and then were asked to select the amount of the loan based on the company's net assets and a predetermined range assigned to each of the depicted trends. The subjects were asked to interpret the type of trend, assess the significance of the trend contained in the graphs or tables, then finally make their decision. After making their decisions, each subject was asked to circle the percentage they wanted to loan each of the fictitious companies.

Secondly, after deciding the loan amount for all three graphs or tables, the subjects were asked to return to the data, review the presentation, provide their impressions of the trend depicted, and offer their opinion of the risk involved in the loan for each of the graphs or tables (see Appendix D.) For this part of the experiment, subjects were asked not to change any of their previous decisions or data when they did their review. Using this particular package added a real-world aspect to the experiment that enabled the researchers to correlate the decision making practices of the subjects tested, with the use of graphs that violate the graph standards under study for this particular thesis.

The final part of each experimental package contained a 20 question demographic survey (see Appendix E) which asked the subjects to select

and circle their age, sex, rank, job experience levels, major Air Force commands they were assigned to prior to attending AFIT, formal or informal graph training if any, how frequently they constructed or looked at graphs as a part of their job, if they constructed them by hand or using a personal computer, and finally what types of computer software did they use to prepare the graphs for their previous assignment. Also, three questions asked the subjects about the experiment itself: were the instructions easy to follow, what was the subjects' interest level in this experiment, and any comments they would like to add concerning the experiment or how it was conducted.

Additionally, the differences in the graphs were minimized to focus more attention on the decision making outcomes achieved by each subject in the experiment. The goal of this thesis was to concentrate on the decisions made by the subjects, not on their perceptions of the significance of the trends depicted by the graphs.

Population and Sample

The population from which the sample was derived is comprised of Air Force decision makers at the intermediate level of the Air Force hierarchy. It included officer, civilian, and enlisted members and was not restricted to any particular types of occupations or Air Force Specialty Codes (AFSC).

Although there were no restrictions, the subjects were mainly from the support career fields such as logistics, acquisitions, information resource management, data management, and fuels management career fields. Also, several banked pilots, navigators, and foreign students

from four different countries were included in the experiment sample since they were currently assigned to AFIT. All were students in AFIT graduate programs or in the Professional Continuing Education Program (PCE) classes. No single occupation received any emphasis because the main focus was on the decision making outcomes of the subjects selected.

The sample population is a non-probability purposive/judgment sample, comprised of various ranks, components, and major commands from the Air Force general population. For convenience and to reduce cost, the samples were selected from those individuals attending AFIT Professional Continuing Education (PCE) courses, and AFIT Master's degree candidates at the Graduate School of Logistics and Acquisitions Management, Air Force Institute of Technology, Wright-Patterson AFB, Ohio. Combining each of these areas gives the most cost-efficient representation of Air Force decision makers at different hierarchy levels, ranks, major commands, and components.

Since decision making in the Air Force is primarily an outcome or practice of individuals that are officers, higher ranking civilians, and enlisted members, then the described samples should adequately cover the population to allow generalizations back to the overall mid-level decision maker population in the Air Force today.

Experiment Development and Testing

The experiment was designed as a 4 x 3 factorial experiment. This design was chosen because it effectively eliminates some of the internal and external validity problems encountered during experimentation (Emory, 1991:431).

Additionally, a designed experiment allows for deliberate control of the experiment so precise comparisons can be made. It allows for maximization of the amount of information obtained between the treatments and the response which in turn produces better results (McClave and Benson, 1991:864).

In this designed factorial experiment, there were two major factors, mode of presentation and trend. For this particular experiment, the levels for the mode of presentation factor were standard bar graphs, bar graphs with a scale break, bar graphs with a non-zero start on the dependent ("Y") axis, and data listed in tabular format. The levels of the trend were increasing, fluctuating, and decreasing scales for the bar graphs or tables. With control already built into the 4 x 3 factorial design, an additional threat to the experiment validity was eliminated.

Emory states there are seven threats to internal validity; does the experiment measure what it intends to measure. The threats are:

1. History. During the course of the experiment, external events occur that confuse/confound the relationship between the independent and dependent variable.

2. Maturation. Changes take place within the subject (physiologically and psychologically) that are a function of time and are not specific to a particular event.

3. Testing. Becoming test-wise; the process of taking a test can affect the scores of the second test; the first test has a learning effect.

4. Instrumentation. A result of changes in the measuring instrument or observer between experiments or observations.

5. Selection. For the experiment to be valid, the experimental groups must be equivalent in every respect. This problem occurs when subjects are randomly assigned to groups.

6. Statistical Regression. When study groups have been selected because of their extreme scores, their tendency will be to migrate toward their long-run mean scores on subsequent tests.

7. Experiment Mortality. Occurs when the composition of the group changes over time; there is attrition in the group. (Emory, 1991:424-426).

The threats to internal validity were minimized in this experiment to the greatest extent possible. History was controlled by administering the experiment immediately after the sample and keeping the data collection period short. Maturation was controlled by limiting the experiment to approximately 20 minutes. This is considered a short enough time to preclude fatigue, boredom or other internal factors in the subjects. The effects of testing were expected to be minimal because no individual will take the test twice.

Instrumentation was controlled by having explicit written instructions contained in the experiment and by the researcher present to monitor the experiment to insure it was conducted precisely the same way with each administration. The random selection of subjects for the experiment controls the effects of statistical regression and selection. Finally, because the experiment was designed to have the questionnaire immediately follow the experiment and the whole procedure take only 20 minutes, the effects of experiment mortality were minimized.

Emory also states that there are threats to external validity, too. They relate to whether or not the results of the experiment can be generalized back to the entire population. They are:

1. Reactivity of testing on the experimental stimulus. The reactive effect of sensitizing the subjects by the pretest so that they respond to the experimental stimulus in a different manner.

2. Interaction of selection and the experimental stimulus. The population from which the researcher selects the subjects may not be the same as the population that the researcher wishes to generalize.

3. Other reactive factors. The experimental setting itself could have a biasing effect on the subjects response to the experimental stimulus (Emory, 1991:427)

While the 4 x 3 factorial designed experiment does a good job of minimizing the effects of internal validity, one factor in external validity can be a problem in this design. Emory suggests that there is a chance for a reactive effect from testing in which the experiment introduces unusual topics or content (Emory, 1991:431). This factor was reduced as much as possible by generating a decision scenario that avoided emotionally charged issues such as pay cuts, women in combat, or gays in the military. The experiment was designed in such a fashion that it does not use unusual graphic capabilities. Finally, this external factor was further minimized by giving each subject the same initial example graph or table (a mask) to anchor their responses.

Data Collection Plan

The scenario was designed to involve each of the subjects in a decision-making process. They were asked to make a decision based on their impression of the trend represented by graphical or tabular data they observed. The decisions were recorded by the subjects below the graphs in the area provided and were completed in a short period of 15 to 20 minutes. The experiment was conducted using a paper format, because paper is the predominant format that graphs are most often observed by the members of the population.

Bar graphs and tables were used in this experiment due to the fact that they are some of the most commonly available forms of graphs and the subjects are more than likely to have observed or used them for decision making in prior job experiences. All graphs were constructed using a personal computer and two popular commercial off-the-shelf software packages called *Quatro Pro* (Borland) and *PC Paintbrush* (Microsoft).

Additionally, questionnaires were constructed that detail specific demographic factors to aid the researchers in drawing additional conclusions about the population segments. These questionnaires were designed to identify any personal factors which may have affected or impacted the subject's decision making abilities during the experiment.

The questionnaires allow the researchers to gather data and compute positive or negative correlation of any differences in decisions to various demographic data such as rank, age, race, sex and occupations of each subject. This was done to rule out any of the most likely confounding variables that could influence the result of the experiment and were not part of the designed independent variables. Some factors such as age, education levels, job experience, or sex may have some minor effects on each subject's decision making capabilities. A decision is a composite of all these factors and what may be decided by one person based on their physical or mental make-up may not necessarily be the same as that made by another in the exact same situation.

The authors felt that the primary factors that would affect the experiment outcome was the subjects' previous exposure to graph related decision making, construction, or graph related training. Therefore,

these items were included in the questionnaire based on a perceived relationship to the actual use of graphs for decision making purposes. Additionally, all questions were justified by their use in providing different views of the data obtained for correlation with the ANOVA to rule out any potential confounds in this experiment.

All data collection took place between the months of April and July, 1993. The data were collected at AFIT for the PCE and master's degree students in a typical AFIT classroom type setting. Approximately 180 subjects participated in the testing from the sample described above.

Plan of Analysis

This experiment design was completely randomized, that is, independent random samples of subjects were selected for each treatment cell. The objective of this design is to compare treatment means (McClave and Benson, 1991:866). The null hypothesis (H_0) generally is that all treatment means are the same, the alternative hypothesis (H_a) is that at least two of the treatment means are different.

The key to analyzing the results of this type experiment is to compare the differences between treatment means to the amount of sampling variability within the treatments. The measurement of differences between treatment means is called **sum of squares for treatment** (SST). It is calculated by the formula:

$$\mathrm{SST} = \sum_{i=1}^{p} n_i(\bar{y}_i - \bar{y})^2 \tag{2}$$

where:

p = the number of treatment levels for the given factor

n_i = the sample size for the *i*th treatment

$\bar{y}_i$ = the mean for the *i*th treatment

$\bar{\bar{y}}$ = the grand (overall) mean for all sample responses

(McClave and Benson, 1991:867)

The amount of dispersion about the treatment means (the sampling variability within the treatment) must also be measured. This is called the **sum of squares for error (SSE)** because it is attributable to sampling error. It is calculated by the formula:

$$SSE = \sum_{j=1}^{n_1}(y_{1j} - \bar{y}_1)^2 + \sum_{j=1}^{n_2}(y_{2j} - \bar{y}_2)^2 + \cdots + \sum_{j=1}^{n_p}(y_{pj} - \bar{y}_p)^2 \quad (3)$$

where:

y_{1j} = the *j*th measurement in sample 1

y_{pj} = the *j*th measurement in sample p

$\bar{y}_1$ = the mean for treatment 1

$\bar{y}_p$ = the mean for treatment p

(McClave and Benson, 1991:867)

In this completely randomized design experiment, the **total sum of squares (SS(Total))** is divided into two parts; the SST and the SSE. In a two factor factorial design experiment, the SST is further subdivided into three parts as shown in Figure 7. They are the main effect sum of squares for factor A or SS(A), the sum of squares for factor B or SS(B), and the interaction sum of squares for factor A and B or SS(AB). This breakdown is needed to determine the nature of each treatment effect on

the response variable. "The interaction component is used to test whether the factors combine to affect the response, while the main effect components are used to determine whether the factors separately affect the response" (McClave and Benson, 1991:906).

As a summation of Figure 7 and the preceding text, the two following general formulas apply:

$$SS(Total) = SST + SSE \tag{4}$$

and

$$SST = SS(A) + SS(B) + SS(AB) \tag{5}$$

The specific formulas for calculating SS(A), SS(B), and SS(AB) are similar in nature to the calculations for SST and can be found in McClave and Benson, pages 1196 - 1197.

In order to make all measures of variability (sum of squares) comparable, each must be converted to mean square terms (MS). To do this, the sum of square term is divided by the degrees of freedom for each of the terms. The terms are calculated as follows:

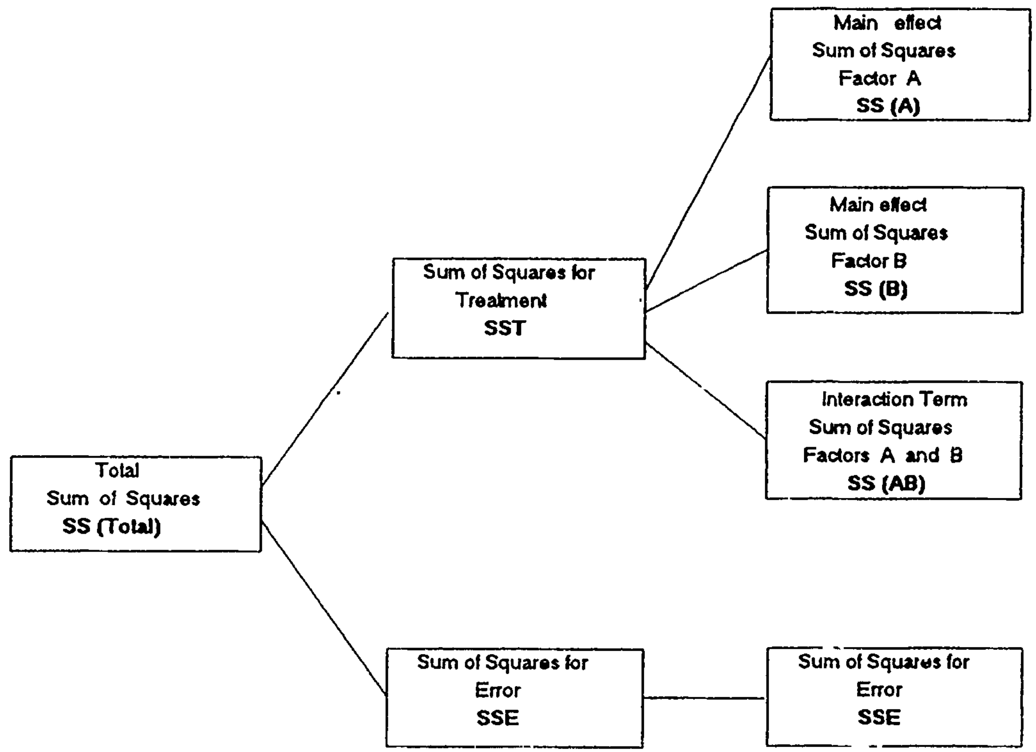
$$MST = \frac{SST}{(p-1)} \tag{6}$$

$$MSE = \frac{MSE}{(n-p)} \tag{7}$$

where:

p = the number of treatment levels for a given factor

n = the overall number of subjects or observations



(McClave and Benson, 1991.906)

Figure 7. Breakdown of the Total Sum of Squares

and

$$MS(A) = \frac{SS(A)}{(a-1)} \tag{8}$$

$$MS(B) = \frac{SS(B)}{(b-1)} \tag{9}$$

$$MS(AB) = \frac{SS(AB)}{(ab-1)} \tag{10}$$

(McClave and Benson, 1991:868)

where:

a = the number of treatment levels in factor A

b = the number of treatment levels in factor B

ab = the product of the number of treatment levels in factor A and B

Formulas 6 and 7 are used in one way analysis of variance (ANOVA) tests, and formulas 7, 8, 9, and 10 are used in multi-factor ANOVAs.

The final value to calculate is a *F* statistic; it is the ratio of the MST to the MSE and is represented by the general formula:

$$F = \frac{MST}{MSE} \tag{11}$$

(McClave and Benson, 1991:868)

To get the *F* statistic for any of the other treatment means, substitute its mean square value for MST, for instance, substitute MS(A) for MST into formula 11.

An *F* statistic of 1 indicates that equal amounts of variance came from between treatment means and within treatment means. This would support the null hypothesis that the treatment means are equal. *F* statistics well in excess of 1 indicate substantial differences exist

between treatment means, enabling us to reject the null hypothesis and accept the alternative hypothesis (McClave and Benson, 1991:868).

To find out whether or not the *F* statistic exceeds 1 by enough to reject H_0, the calculated F value must be compared to the F table value of the level of alpha selected for the test. Most statistical packages will compute a level of significance or "p" value for the *F* statistic. If the p value is greater than the alpha selected for the test, then H_0 should be accepted. If "p" is less than alpha, H_0 should be rejected and H_a accepted.

Once analysis is completed on the treatment means and if the interaction effect, or one or more of the main effects are significant, the treatment means should be compared to determine where there are significant differences.

One method of making multiple comparisons is the Bonferroni procedure. It is a simple, conservative method to use and is calculated by the following formula:

$$(\bar{y}_i - \bar{y}_j) \pm t_{\alpha/2c,df}\, S \sqrt{\frac{1}{n_i} + \frac{1}{n_j}} \qquad (12)$$

(McClave and Benson, 1991:874)

where:

$\bar{y}_i$ = mean of treatment i

$\bar{y}_j$ = mean of treatment j

S = the square root of MSE

n_i = the number of samples in treatment i

n_j = the number of samples in treatment j

$t_{\alpha/2c,\, df}$ = tabulated value of t

where:

c = the number of treatment pair combinations

df = the degrees of freedom (n-p)

This procedure produces a confidence interval that contains all the true treatment mean differences. Intervals that contain zero support the null hypothesis. If the interval endpoints are both positive, or both negative (do not include zero), then a significant difference exists at the selected alpha and H_0 should be rejected and H_a accepted (McClave and Benson, 1991:873).

Based on this explanation of principles and terms involved in a factorial designed experiment, the following procedures were used:

1. Partition SS(Total) into the SSE and SST components using *Statgraphics Version 6.0* by Manugistics.

2. Use the *F* ratio of MST to MSE to test the null hypothesis that the treatment means are equal.

   a. If the test results in non rejection of the null hypothesis, consider the possibility that the response is unrelated to the factors.

   b. If the test results in rejection of the null hypothesis.

3. Partition SST into SS(A), SS(B), and SS(AB) using *Statgraphics* (where factor A is the display mode and factor B is the trend type).

4. Test the null hypothesis that the factors for display mode and trend type do not interact to affect the response by computing the *F* ratio of the MS(AB) to MSE. If the test

results in rejection of the null hypothesis, conclude that the two factors interact to affect the mean response.

5. Conduct tests of two null hypotheses that the mean response is the same at each level of display mode and trend type. Compute two *F* ratios by comparing MS(A) and MS(B) to MSE. If one or both tests result in rejection of the null hypothesis, conclude that the factor affects the mean response.

6. If the test for interaction, or one or more main effects in step 4 or 5 is significant, use the Bonferroni multiple comparisons procedure to compare pairs of treatment means.

(Adapted from McClave and Benson, 1991:907).

These procedures enabled the researchers to test the following hypotheses:

TEST FOR TREATMENT MEANS

H_o : No difference among display mode or trend type means
H_a : At lear [illegible] treatment means differ

Formula [illegible] se MST   Reject H_o if p <= alpha

TEST FOR DISPLAY MODE AND TREND TYPE INTERACTION

H_o : Display mode and trend type do not interact
H_a : The factors do interact to affect the response mean

Formula 11 use MS(AB)   Reject H_o if p <= alpha

TEST FOR MAIN EFFECT OF DISPLAY MODE

H_o : No difference among the 4 display mode means
H_a : At least two display mode means are different

Formula 11 use MS(A)   Reject H_o if p <= alpha

TEST FOR MAIN EFFECT OF TREND TYPE

H_0 : No difference among the 3 trend type means
H_a : At least two trend types means are different

Formula 11 use MS(B) Reject H_0 if p <= alpha

(Adapted from McClave and Benson, 1991:908)

Sample Statistical Analysis

A sample statistical analysis was conducted on the dummy data located in Table 2 using *Statgraphics, Version 6.0,* by Manugistics. This software package was selected because of its statistical capabilities and because it operated on a personal computer in a user-friendly, mouse-driven environment. *Statgraphics* was used to gather summary statistics such as mean, standard deviation, and standard errors, and to conduct frequency tabulations, one-way analysis of variances (ANOVA), multi-factor ANOVAs, and multiple range tests (Bonferroni procedures). All tests were conducted at the 95% confidence level (alpha = .05).

Tables 3-6 represent the output of the *Statgraphics* software package for the analysis of variance and Bonferroni procedures. Each table represents a separate statistical procedure which is annotated in bold print. These annotations reflect comparisons with the formulas and principles described in the Plan of Analysis section. Any further explanations of a table are detailed below a double line at the end of the output from the software package.

TABLE 2

Dummy Data for Experimental Analysis

ID#	Resp	Norm	Disp-type	Trend-type	Tr-impr	Risk	Sex
1	75	25	Z	I	7	3	1
2	80	30	NZ	I	8	2	2
3	80	30	SB	I	9	1	1
4	70	20	T	I	8	3	1
5	50	25	Z	F	5	5	1
6	40	15	NZ	F	6	4	2
7	60	35	SB	F	5	6	2
8	55	30	T	F	6	5	1
9	30	30	Z	D	3	7	1
10	15	15	NZ	D	1	9	1
11	25	25	SB	D	4	9	2
12	25	25	T	D	3	7	1
13	75	25	Z	I	7	3	2
14	85	35	NZ	I	9	2	1
15	80	30	SB	I	8	1	1
16	80	30	T	I	7	3	2
17	50	25	Z	F	5	7	2
18	45	20	NZ	F	6	4	1
19	60	35	SB	F	5	6	1
20	55	30	T	F	6	4	1
21	20	20	Z	D	3	6	2
22	15	15	NZ	D	1	9	1
23	20	20	SB	D	2	8	2
24	25	25	T	D	4	7	1
25	75	25	Z	I	7	3	2
26	80	30	NZ	I	7	2	2
27	80	30	SB	I	9	1	1
28	70	20	T	I	8	3	1
29	50	25	Z	F	7	6	2
30	45	20	NZ	F	6	4	2
31	55	30	SB	F	5	6	1
32	55	30	T	F	6	4	2
33	30	30	Z	D	3	6	2
34	15	15	NZ	D	1	9	1
35	30	30	SB	D	2	8	1
36	25	25	T	D	7	7	1
37	75	25	Z	I	9	3	2
38	85	35	NZ	I	8	2	2
39	80	30	SB	I	7	1	1
40	65	15	T	I	7	3	2

TABLE 2 (con't.)

Dummy Data for Experimental Analysis

ID#	Resp	Norm	Disp-type	Trend-type	Tr-impr	Risk	Sex
41	50	25	Z	F	5	1	1
42	45	20	NZ	F	6	2	2
43	60	35	SB	F	5	3	1
44	55	30	T	F	6	4	2
45	35	35	Z	D	3	7	1
46	15	15	NZ	D	2	9	2
47	20	20	SB	D	4	8	1
48	25	25	T	D	2	7	2
49	75	25	Z	I	7	3	1
50	80	30	NZ	I	8	2	1
51	80	30	SB	I	9	1	2
52	70	20	T	I	7	3	2
53	50	25	Z	F	5	5	2
54	45	20	NZ	F	6	4	1
55	50	25	SB	F	5	6	1
56	55	30	T	F	6	4	1
57	30	30	Z	D	3	7	1
58	15	15	NZ	D	1	9	1
59	20	20	SB	D	2	8	2
60	35	35	T	D	3	7	1
Totals	3040	1540			322	289	
Means	50.667	25.667			5.3667	4.8167	

Explanation of Variable Names

ID# - Identification or case number

Resp - Subject's loan decision response

Norm - Subject's normalized response for loan decision

Disp_Type - Type of display (Z = Zero, NZ = Non-zero, SB = Scale Break, T = Table)

Tr_Type - Type of net asset trend (I = Increasing, F = Fluctuating, D = Decreasing)

Tr_Impr - Subject's trend impression on a 9 point scale (1 = Unimpressive, 9 = Impressive)

Risk Subject's risk assessment response on a 9 point scale (1 = Low Risk, 9 = High Risk)

Sex - Subject's gender (1 = Male, 2 = Female)

TABLE 3

Multi-Factor Analysis of Variance
for Comparison of Trend Type and Display Mode to
The Response Variables

Analysis of Variance for dummy.norm - Type I Sums of Squares

Source of Variation Factor	Sum of Squares SS		d.f.	Mean square MS		F-ratio F	Sig. Level p
MAIN EFFECTS							
A:trend_type	**SS(A)**	143.33333	2	**MS(A)**	71.66667	6.491	.0032
B:disp_type	**SS(B)**	316.66667	3	**MS(B)**	105.55556	9.560	.0000
INTERACTIONS							
AB	**SS(AB)**	1133.3333	6	**MS(AB)**	188.88889	17.107	.0000
RESIDUAL(Error)	**SSE**	530.00000	48	**MSE**	11.041667		
TOTAL	SS(Total)	2123.3333	59				

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

NOTE: The results of this analysis are:

TEST FOR DISPLAY MODE AND TREND TYPE INTERACTION

H_o : Display mode and trend type do not interact
H_a : The factors do interact to affect the response mean

Formula 11 use MS(AB) **Rejected H_o p <= alpha**

TEST FOR MAIN EFFECT OF DISPLAY MODE

H_o : No difference among the 4 means of display mode
H_a : At least two display mode means are different

Formula 11 use MS(A) **Rejected H_o p <= alpha**

TEST FOR MAIN EFFECT OF TREND TYPE

H_o : No difference among the 3 means of trend type
H_a : At least two trend types means are different

Formula 11 use MS(B) **Rejected H_o p <= alpha**

TABLE 4

Multiple Range Test - Bonferroni Procedure
for Trend Type

Multiple range analysis for dummy.norm by dummy.trend_type

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
D	20	23.500000	X
F	2C	26.500000	X
I	20	27.000000	X

contrast	difference	+/- limits		RANGE		
I - F	0.50000	2.60729		-2.10729	to	+3.10729
I - D	3.50000	2.60729	*	+ .89271	to	+6.10729
F - D	3.00000	2.60729	*	+ .32971	to	+5.60729

* denotes a statistically significant difference.

Note:

The first contrast (I - F) contains zero so the difference in means is nct significant.

The second and third contrasts (I -D) and (F - D) do not contain zero so the differences in means for these two groups are significant at alpha = .05.

The range information was added to help the reader understand this computer product.

TABLE 5

Multiple Range Test - Bonferroni Procedure
for Display Mode

Multiple range analysis for dummy.norm by dummy.disp_type

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
NZ	15	22.000000	X
T	15	26.000000	X
Z	15	26.333333	X
SB	15	28.333333	X

contrast	difference	+/- limits	
Z - NZ	4.33333	3.33971	*
Z - SB	-2.00000	3.33971	
Z - T	0.33333	3.33971	
NZ - SB	-6.33333	3.33971	*
NZ - T	-4.00000	3.33971	*
SB - T	2.33333	3.33971	

* denotes a statistically significant difference.

See notes from Table 4.

TABLE 6

One-Way Analysis of Variance
for Comparison of Demographic Factor Sex to
Response Variables

One-Way Analysis of Variance

Data: dummy.norm

Level codes: dummy.sex

Labels:

Means plot: LSD   Confidence level: 95   Range test: LSD

One-Way Analysis of variance

Source of Variation Factor		Sum of Squares SS	d.f.	Mean square MS	F-ratio F	Sig. Level p
Between groups	**SST**	33.8537	1	33.853695	.940	.3467
Within groups	**SSE**	2089.4796	58	36.025511		
Total	**SS(Total)**	2123.3333	59			

0 missing value(s) have been excluded.

NOTE: The results of this analysis are:

TEST FOR TREATMENT MEANS

H_o : No difference among gender means
H_a : At least two treatment means differ

Formula 11 use MST   **Accepted H_o , p > alpha**

Summary

The experiment followed the 4 x 3 factorial design to determine if display mode, trend type, or demographics affected a subjects' loan decision, trend impression, or risk assessment. The graphs and tables were designed using *Quatro-Pro* and *PC Paintbrush*. ANOVA was used to determine if there were any differences in the mean responses and multiple range tests (Bonferroni procedures) were used to determine which factor levels were significantly different. Chapter V, Conclusions and Recommendations, contains all of the conclusions gathered from the experiment and recommendations for future studies.

IV. Analysis and Findings

This chapter will show the results of each Analysis of Variance (ANOVA) conducted on the experiment package as described in the Plan of Analysis contained in Chapter 3, Methodology. Additionally, a detailed description of each step of the analysis is contained in the section Experimental Results. Chapter 5, Conclusion, contains the summary of all the results as well as recommendations for future research and areas needing additional experimental work and analysis.

Experimental Results

The complete description of all terms and variables used within the experiment and abbreviations contained along the X and Y axes of the cells in the spreadsheet file are contained in Appendix F. Appendix G contains the responses from all of the 180 tested subjects to include the associated demographic responses.

Since the decreasing, fluctuating, and increasing trend data presentation modes used a different percentage (response) scale for the loan decision response variable, all of the data were normalized. Normalization means that the percentages had to start from the same point on the scale for each of the tested trends. To do this, 25 percent was subtracted from the loan decision responses of subjects viewing fluctuating trend graphs and tables. Fifty percent was subtracted from the loan decision responses of subjects viewing increasing trend graphs and tables.

The first step in the analysis was to conduct a two factor Analysis

of Variance (ANOVA) on all three response variables collected during the experiment. The consolidated output from *Statgraphics* is presented in Table 7. The subjects' responses for loan decisions, trend interpretation, and risk analysis were analyzed by trend type and display mode factors.

The next step was to evaluate the experimental null hypotheses:

TEST FOR DISPLAY MODE AND TREND TYPE INTERACTION

H_o : Display mode and trend type do not interact
H_a : The factors do interact to affect the response mean

Formula 11 use MS(AB) Reject H_o if p <= alpha

TEST FOR MAIN EFFECT OF DISPLAY MODE

H_o : No difference among the 4 display mode means
H_a : At least two display mode means are different

Formula 11 use MS(A) Reject H_o if p <= alpha

TEST FOR MAIN EFFECT OF TREND TYPE

H_o : No difference among the 3 trend type means
H_a : At least two trend types means are different

Formula 11 use MS(B) Reject H_o if p <= alpha

(Adapted from McClave and Benson, 1991:908)

As the researchers reviewed the results, one result that stood out was the main effect for trend type. In each response variable, the main effect significance level (p value) was .0000 (see Table 7). A multiple range test (Bonferroni procedure) was conducted on the trend type factor for all three response variables and it was found that there was a significant difference in all three combinations of trend across all three response variables. Therefore, the null hypothesis was rejected and the alternative hypothesis accepted. Although the researchers felt

TABLE 7

Consolidation of Multifactor ANOVA
on Loan Decision, Trend Impression, and Risk Assessment
Response Variables

Loan Decision

Variation Source	Sum Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:display mode	292.7778	3	97.5926	2.421	.0652
B:trend type	2436.7593	2	1218.3796	30.223	.0000
INTERACTIONS					
AB	830.27778	6	138.37963	3.433	.0025

Trend Impression

Variation Source	Sum Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:display mode	61.78333	3	20.59444	5.126	.0017
B:trend type	446.20370	2	223.10185	55.529	.0000
INTERACTIONS					
AB	44.522222	6	7.4203704	1.847	.0881

Risk Assessment

Variation Source	Sum Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:display mode	17.26667	3	5.75556	1.455	.2258
B:trend type	390.00370	2	195.00185	49.310	.0000
INTERACTIONS					
AB	106.45556	6	17.742593	4.487	.0002

that this factor would lead to a high level of significance, the results were more significant than anticipated. No further analysis was conducted on this factor because the results were so resounding.

The interaction term was then observed for each of the three response variables. At the alpha = .10 level, the null hypothesis was rejected and the alternative hypothesis accepted. However, at the alpha = .05 level, we would accept the null hypothesis for the trend impression response variable.

Finally, the main effect for display mode was observed. At the alpha = .10 and alpha = .05 levels we accepted the null hypothesis (that there is no difference in the four display mode means) for the risk assessment response variable because the level of significance (p value) was .2258. However, the two other response variables showed different results. For the loan decision response, the level of significance was .0652. For this response, the null hypothesis was accepted at alpha = .10 and rejected at alpha = .05. For the trend impression responses the significance level was .0017. This resulted in the rejection of the null hypothesis and acceptance of the alternative hypothesis at the alpha = .05 level. The Bonferroni procedure was then conducted to determine which types of trends exhibited significant differences within each response variable. The results are summarized in Table 8.

The results at this analytical level help answer investigative question 11. Displays have differing modes of presentation and are interpreted differently, to result in widely varied decisions by Air Force decision makers.

Additionally, the trend impression results were very substantial

TABLE 8

Overall Summary of Multifactor ANOVA for Display and Trend Factors

Response Variable	Display Mode	n	Mean/ Differences	Standard Error (Internal)	p/ Significance Level
Loan Decision		540	24.9074	.2732	.0652
	Z	135	25.7037	.5882	-
	NZ	135	23.7073	.5970	-
	SB	135	25.1418	.6152	-
	T	135	25.0741	.5256	-
	Z-NZ		2.0000	-	*****
	Z-SB		0.5556	-	-
	Z-T		0.6296	-	-
	NZ-SB		-1.4444	-	**
	NZ-T		-1.3704	-	**
	SB-T		0.0741	-	-
Trend Interpretation		540	5.4241	.0863	.0017
	Z	135	5.8296	1710	-
	NZ	135	5.6740	.1921	-
	SB	135	5.1851	.2047	-
	T	135	5.0074	.1906	-
	Z-NZ		0.1556	-	-
	Z-SB		0.6444	-	**
	Z-T		0.8222	-	*****
	NZ-SB		0.4889	-	***
	NZ-T		0.6667	-	****
	SB-T		0.1778	-	-
Risk Assessment		540	4.4074	.0856	.2258
	Z	135	4.4444	.1789	-
	NZ	135	4.9333	1962	-
	SB	135	4.6667	.2090	-
	T	135	4 7851	.1693	-
	Z-NZ		-0.4889	-	***
	Z-SB		-0.2222	-	-
	Z-T		0.3407	-	*
	NZ-SB		0.2667	-	-
	NZ-T		0.1482	-	-
	SB-T		-0.1185	-	-

Z - Graphs drawn from zero on Y axis
NZ - Graphs drawn from non-zero point on Y axis
SB - Graphs drawn with scale break on Y axis
T - Data presented in tabular format

***** - p < .001
**** - p < .010
*** - p < 050
** - p < .100
* - p < .150

because they supported the results of many previous researchers (i.e. Johnson, Taylor, Larkin, Kern, and Carvalho and McMillan) in that generally, differences in display mode led subjects to interpret the underlying data differently.

Because of the differing results in the main effect for display mode and because the interaction term was so significant, it was decided that further data analysis was needed. The first approach was to divide the large set of data into three separate files, then to analyze each file individually. To remove the effects of trend type, the data were segregated into files by trend type; one file for increasing trend, one for fluctuating trend, and another for decreasing trend. Each file contained 180 responses, three individual responses for each of the 60 subjects that had that type trend. Because of the trend factor was removed, a one-way analysis of variance was conducted one each of the files.

The first step in this portion of the analysis was to look at the data for increasing trends. The results of the analysis for experimental packages that displayed increasing trend graphs are summarized in Table 9. Overall, display mode did not have a significant effect on any of the response variables with $p > .2000$ in each case. Because of this the null hypothesis for main effect for display mode (that there was no difference in display mode response means), was accepted.

In light of the previously summarized results in Table 7 and Table 8, these new results surprised the researchers. A closer look at this data, using the Bonferroni procedure, showed only two (paired)

TABLE 9

Summary of ANOVA Results for Increasing Trend Data

Response Variable	Display Mode	n	Mean/ Differences	Standard Error (Internal)	p/ Significance Level
Loan Decision		180	27.4166	.4769	.7393
	Z	45	26.6667	1.0175	-
	NZ	45	28.1111	.8600	-
	SB	45	27.2222	.9607	-
	T	45	27.6667	.9347	-
	Z - NZ		-1.4444	-	-
	Z - SB		-0.5555	-	-
	Z - T		-1.0000	-	-
	NZ - SB		0.8889	-	-
	NZ - T		0.4444	-	-
	SB - T		-0.4444	-	-
Trend Interpretation		180	6.6556	.1167	.2325
	Z	45	6.5778	.2190	-
	NZ	45	7.0444	.2107	-
	SB	45	6.3778	.2952	-
	T	45	6.6222	.2298	-
	Z - NZ		-0.4667	-	-
	Z - SB		0.2000	-	-
	Z - T		-0.0400	-	-
	NZ - SB		0.6667	-	***
	NZ - T		0.4222	-	-
	SB - T		-0.2444	-	-
Risk Assessment		180	3.7611	1218	.2353
	Z	45	3.7333	1967	-
	NZ	45	3.4000	.2279	-
	SB	45	3.8000	2818	-
	T	45	4.1111	.2586	-
	Z - NZ		0.3333	-	-
	Z - SB		-0.0667	-	-
	Z - T		-0.3778	-	-
	NZ - SB		-0.4000	-	-
	NZ - T		-0.7111	-	**
	SB - T		-0.3111	-	-

Z - Graphs drawn from zero on Y axis
NZ - Graphs drawn from non-zero point on Y axis
SB - Graphs drawn with scale break on Y axis
T - Data presented in tabular format

***** - $p < .001$
**** - $p < .010$
*** - $p < .050$
** - $p < .100$
* - $p < .150$

differences. The first was for the trend impression response variable. Responses based on graphs drawn from the non-zero point on the y axis were different from graphs drawn with scale breaks; this was at alpha = .05. The other significant difference was for the risk assessment response variable. Responses based on graphs drawn from the non-zero point on the y axis were different from those based on tabular data at the alpha = .10 level.

The next step in the data analysis was to examine the data for fluctuating trends. The summarized results are shown in Table 10. Contrary to the results seen with increasing trend data, two of the fluctuating trend response variables showed a very high level of significance; the third showed a moderate level of significance. The loan decision response variable and the risk assessment response variable had p values of .0001 and .0000 respectively. This was significant at well below alpha = .05; thus, the null hypothesis was rejected and the alternative hypothesis (that at least two of the display mode means differed) was accepted. The trend impression response variable had a p value of .1386. The null hypothesis was accepted at alpha = .10.

Once again, the Bonferroni procedure was run to determine where the differences between paired means existed. There were numerous paired differences as annotated in Table 10. The most significant were the differences in responses between graphs drawn with an non-zero start on the y axis and all other display modes. These differences were significant at the alpha = .01 level or less for both the loan decision and risk assessment response variables.

TABLE 10

Summary of ANOVA Results for Fluctuating Trend Data

Response Variable	Display Mode	n	Mean/ Differences	Standard Error (Internal)	p/ Significance Level
Loan Decision		180	25.0833	.4012	.0001
	Z	45	26.5556	.9773	-
	NZ	45	21.2222	.9287	-
	SB	45	26.3333	.9718	-
	T	45	26.2222	.7970	-
	Z - NZ		5.3333	-	*****
	Z - SB		0.2222	-	-
	Z - T		0.3333	-	-
	NZ - SB		-5.1111	-	*****
	NZ - T		-5.0000	-	*****
	SB - T		0.1111	-	-
Trend Impression		180	5.1278	.1497	.1386
	Z	45	5.5333	.2818	-
	NZ	45	5.4222	.3089	-
	SB	45	4.7333	.3055	-
	T	45	4.8222	.2812	-
	Z - NZ		0.1111	-	-
	Z - SB		0.8000	-	**
	Z - T		0.7111	-	**
	NZ - SB		0.6889	-	*
	NZ - T		0.6000	-	-
	SB - T		-0.0889	-	-
Risk Assessment		180	4.5389	.1281	.0000
	Z	45	4.1333	.3204	-
	NZ	45	5.6000	.3262	-
	SB	45	3.7556	.3100	-
	T	45	4.6667	.2807	-
	Z - NZ		-1.4667	-	*****
	Z - SB		0.3778	-	-
	Z - T		-0.5333	-	*
	NZ - SB		1.8444	-	*****
	NZ - T		0.9333	-	****
	SB - T		-0.9111	-	**

Z - Graphs drawn from zero on Y axis
NZ - Graphs drawn from non-zero point on Y axis
SB - Graphs drawn with scale break on Y axis
T - Data presented in tabular format

***** - $p < .001$
**** - $p < 010$
*** - $p < 050$
** - $p < .100$
* - $p < .150$

The final step of this phase of the data analysis was to examine the data for decreasing trends. Again, a one-way ANOVA was conducted followed by the Bonferroni procedure. The results are summarized in Table 11. The most significant differences were noted with the trend impression response variable. The p value was .0057 and the null hypothesis was rejected at the alpha = .01 level. Also of significance were differences between all display mode means *except* graphs starting from an non-zero point on the y axis and graphs drawn with scale breaks. These results were anticipated by the researchers and support the results of previous research by Kern and Carvalho and McMillan.

In this portion of the analysis, the other two response variables displayed less significance. For the risk assessment response variable, the null hypothesis was rejected at alpha =.10 (p value was .0926). The multiple range test showed a significant difference between the response means of graphs drawn with scale breaks and two other display modes; those based on graphs drawn from the zero point on the y axis and those based on tabular data. The loan decision response variable was even less affected by the display mode (p = .1335), and the null hypothesis was accepted. Of note in this response variable were differences between graphs drawn from zero on the y axis and all three other display modes. Each difference was significant at the alpha = .10 level or less.

Overall, it can be stated that viewers of fluctuating trend data and decreasing trend data made different loan decisions, got differing trend impressions, and assessed risk differently based on what they observed in the displays. Within these two response variables, graphs

TABLE 11

Summary of ANOVA Results for Decreasing Trend Data

Response Variable	Display Mode	n	Mean/ Differences	Standard Error (Internal)	p/ Significance Level
Loan Decision		180	22.2222	.4149	.1355
	Z	45	23.8889	1.0285	-
	NZ	45	21.7778	.9944	-
	SB	45	21.8889	1.1043	-
	T	45	21.3333	.7177	-
	Z - NZ		2.1111	-	***
	Z - SB		2.0000	-	***
	Z - T		2.5556	-	****
	NZ - SB		-0.1111	-	-
	NZ - T		0.4444	-	-
	SB - T		0.5555	-	-
Trend Impression		180	4.4889	.1769	.0057
	Z	45	5.3778	.3471	-
	NZ	45	4.5556	.3532	-
	SB	45	4.4444	.3912	-
	T	45	3.5778	.3056	-
	Z - NZ		0.8222	-	-
	Z - SB		0.9333	-	****
	Z - T		1.8000	-	*****
	NZ - SB		0.1111	-	***
	NZ - T		0.9778	-	****
	SB - T		0.8667	-	-
Decreasing		180	5.8222	.1482	.0926
	Z	45	5.4667	.3372	-
	NZ	45	5.8000	.3557	-
	SB	45	6.4444	.3402	-
	T	45	5.5778	.3023	-
	Z - NZ		-0.3330	-	-
	Z - SB		-0.9778	-	***
	Z - T		-0.1111	-	-
	NZ - SB		-0.6444	-	*
	NZ - T		0.2220	-	-
	SB - T		0.8667	-	***

Z - Graphs drawn from zero on Y axis
NZ - Graphs drawn from non-zero point on Y axis
SB - Graphs drawn with scale break on Y axis
T - Data presented in tabular format

***** - $p < .001$
**** - $p <$ 010
*** - $p < .050$
** - $p < .100$
* - $p < .150$

drawn from the non-zero point on the y axis generally tended to create more significant differences in subject's responses. Graphs drawn with scale breaks also showed some differences with other display modes. According to this analysis, subjects who viewed increasing trend graphs or tables also had differences in their responses, however, the differences were not significant enough to be attributable to the main effect (display mode).

Because these results did not entirely support the result of previous research, the researchers felt that there may be a confounding variable that was not intentionally designed into the experiment. As the researchers reviewed the experimental packages, they observed that some subjects had calculated the percentage of change in the data in the margins of the data display pages. This observation was important because each subject received an experimental package with three scenarios, each representing a different company, each with a different level of net asset values. For instance, subjects viewing company A saw an increasing trend that started at $85,000 and ended at $100,000. The four year increase was $15,000 (evenly increasing each year). That same subject also viewed the data for company C. This company's net asset trend also increased by $15,000 but the increase was from $10,000 to $25,000. It was can be seen that the rate of change (increase) for company C was larger than that of company A. This may have affected the subjects' responses for loan decision, trend interpretation, and risk assessment.

In an attempt to remove the effects of this unplanned potential factor, the original data set was subdivided into three new files. Each

TABLE 12

Summary of ANOVA Results for Large Companies

Response Variable	Display Mode	n	Mean/ Differences	Standard Error (Internal)	p/ Significance Level
Loan Decision		180	27.2500	.4561	.0648
	Z	45	28.5556	.8936	-
	NZ	45	25.4444	.9773	-
	SB	45	28.2222	.9816	-
	T	45	26.7778	9011	-
	Z - NZ		3.1111	-	***
	Z - SB		0.3333	-	-
	Z - T		1.7778	-	-
	NZ - SB		-2.7778	-	***
	NZ - T		-1.3333	-	-
	SB - T		1.4444	-	-
Trend Impression		180	5.3056	.1531	.5556
	Z	45	5.3333	.3015	-
	NZ	45	5.6222	.3230	-
	SB	45	5.2667	.3294	-
	T	45	5.0000	.3048	-
	Z - NZ		-0.2889	-	-
	Z - SB		0.0667	-	-
	Z - T		0.3333	-	-
	NZ - SB		0.3556	-	-
	NZ - T		0.6222	-	*
	SB - T		0.2667	-	-
Risk Assessment		180	3.8722	.1307	0483
	Z	45	3.2444	.2088	-
	NZ	45	4.2000	.3204	-
	SB	45	3.9778	.3170	-
	T	45	4.0667	.2667	-
	Z - NZ		-0.9566	-	*****
	Z - SB		-0 7333	-	****
	Z - T		-0.8222	-	***
	NZ - SB		0.2222	-	-
	NZ - T		0 1333	-	-
	SB - T		0.0889	-	-

Z - Graphs drawn from zero on Y axis
NZ - Graphs drawn from non-zero point on Y axis
SB - Graphs drawn with scale break on Y axis
T - Data presented in tabular format

***** - p < 001
**** - p < 010
*** - p < 050
** - p < 100
* - p < .150

new file represented a certain level of net assets. The file designated "large" represented all companies (A, D, and G) that had assets in the $85,000 to $100,000 range, regardless of the type of trend presented. The file "medium" contained all companies with assets in the $40,000 to $55,000 range (companies B, E, and H). The final file contained the remainder of the companies (C, F, and I) that had net assets in the $10,000 to $25,000 range. Each file contained one set of responses for each of the 180 subjects. This phase of the analysis is summarized in Tables 12, 13, and 14. At this point it should also be noted that these files were also used to complete the demographic analysis.

The first step in this phase of analysis was to conduct a one-way ANOVA on the data in the file representing companies with relatively large net assets. It was found that display mode had a significant effect in two of the three response variables (see Table 12). The null hypothesis was rejected for the loan decision variable at alpha = .10, and was rejected at the alpha = .05 level for the risk assessment response variable. The p values were .0648 and .0483 respectively. The null hypothesis was accepted for the trend response variable, the p value was .5556.

The result of the Bonferroni procedures for this data set revealed that there were significant differences in five display mode pairs. The first two were between zero and non-zero y axis start graphs for the loan decision and risk assessment response variables. The next two were for the risk assessment response variable and were between zero start graphs and scale break graphs, and between zero start graphs and tables. The last significant difference was between non-zero start graphs and

TABLE 13

Summary of ANOVA Results for Medium Sized Companies

Response Variable	Display Mode	n	Mean/ Differences	Standard Error (Internal)	p/ Significance Level
Loan Decision		180	25.0000	.4096	.0107
	Z	45	26.8889	8600	-
	NZ	45	23.1111	.9169	-
	SB	45	24.4444	.9824	-
	T	45	25.5556	.8291	-
	Z - NZ		3.7778	-	*****
	Z - SB		2.4444	-	***
	Z - T		1.3333	-	-
	NZ - SB		-1.3333	-	-
	NZ - T		-2.4444	-	***
	SB - T		-1.1111	-	-
Trend Impression		180	5.2944	.1258	.0660
	Z	45	5.6667	.2291	-
	NZ	45	5.5778	.2869	-
	SB	45	5.0888	.3238	-
	T	45	4.8444	.2912	-
	Z - NZ		0.0889	-	-
	Z - SB		0.5778	-	*
	Z - T		0.8222	-	***
	NZ - SB		0.4889	-	-
	NZ - T		0.7333	-	***
	SB - T		0.2444	-	-
Risk Assessment		180	4.5889	.1174	.3038
	Z	45	4.3111	.2417	-
	NZ	45	4.9111	2804	-
	SB	45	4.4667	.3075	-
	T	45	4.6667	2225	-
	Z - NZ		-0.6000	-	**
	Z - SB		-0.1556	-	-
	Z - T		-0.3556	-	-
	NZ - SB		0.4444	-	-
	NZ - T		0.2444	-	-
	SB - T		-0.2000	-	-

Z - Graphs drawn from zero on Y axis
NZ - Graphs drawn from non-zero point on Y axis
SB - Graphs drawn with scale break on Y axis
T - Data presented in tabular format

***** - p < 001
**** - p < .010
*** - p < .050
** - p < .100
* - p < .150

scale break graphs for the loan decision response variable. All were significant at alpha = .05 or less.

The next step was to perform the same analyses on the file representing companies with medium net assets. The results (see Table 13) showed display mode to have a significant effect on the loan decision response; the null hypothesis was rejected at alpha = .05. The null hypothesis was also rejected for the trend impression response variable; rejection was at alpha = .10. The p values were .0107 and .0660 respectively. Contrary to these response variables, the display mode was not significant in the risk assessment response (p = .3038), therefore, the null hypothesis was accepted.

Bonferroni procedures were then conducted on this data set. Significant differences were noted in five pairs of display modes. The first significant difference was between non-zero start graphs and tables. It was significant at alpha = .05, and appeared in both the loan decision and trend impression response variables. In the loan decision response variable, there were two more significant differences. The responses for zero start graphs differed from two other display modes; non-zero starts and scale break graphs. The former had a p value of less than .001, the latter had a p value of less than .05. The last significant difference occurred in the trend impression response variable. At alpha = .05 or less, the responses for zero start graphs were significantly different from the tabular data mode.

The final step in this phase was to analyze the file containing the data for companies with relatively small net assets. The summary of these analyses are contained in Table 14. In the analysis of variance,

TABLE 14

Summary of ANOVA Results for Small Companies

Response Variable	Display Mode	n	Mean/ Differences	Standard Error (Internal)	p/ Significance Level
Loan Decision		180	22.4722	.4298	.7415
	Z	45	21.6667	1.0175	-
	NZ	45	22.5556	1.1637	-
	SB	45	22.7778	1.0842	-
	T	45	22.8889	.9196	-
	Z-NZ		-0.8889	-	-
	Z-SB		-1.1111	-	-
	Z-T		-1.2222	-	-
	NZ-SB		-0.2222	-	-
	NZ-T		-0.3333	-	-
	SB-T		-0.1111	-	-
Trend Impression		180	5.6722	.1675	.0183
	Z	45	6.4889	.3282	-
	NZ	45	5.8222	.3870	-
	SB	45	5.2000	.4115	-
	T	45	5.1778	.3909	-
	Z-NZ		0.6667	-	-
	Z-SB		1.2889	-	*****
	Z-T		1.3111	-	*****
	NZ-SB		0.6222	-	-
	NZ-T		0.6444	-	-
	SB-T		0.0222	-	-
Risk Assessment		180	5.6611	.1494	.9595
	Z	45	5.7778	.3421	-
	NZ	45	5.6889	.3811	-
	SB	45	5.5560	.4145	-
	T	45	5.6222	.3368	-
	Z-NZ		0.0889	-	-
	Z-SB		0.2222	-	-
	Z-T		0.1557	-	-
	NZ-SB		0.1333	-	-
	NZ-T		0.0667	-	-
	SB-T		-0.0667	-	-

Z - Graphs drawn from zero on Y axis
NZ - Graphs drawn from non-zero point on Y axis
SB - Graphs drawn with scale break on Y axis
T - Data presented in tabular format

***** - $p < .001$
**** - $p < .010$
*** - $p < .050$
** - $p < .100$
* - $p < .150$

only one response variable, trend impression, showed any significant effect from display modes. With a p value of .0183, the hull hypothesis was rejected at alpha = .05. For the two other response variables, loan decision and risk assessment, the null hypothesis was accepted. As with all other analyses to this point, the Bonferroni procedure was run and only two significant differences were observed between display mode pairs. Both were in the trend impression response variable and both were significant at alpha = .01. The differences were between zero start and scale break graphs, and between zero start graphs and tables.

It appeared from this phase of the analysis that loan decisions were more difficult to make and trend impressions were more difficult to form (as a result of the large variance in responses) with data representing large and medium sized companies. It could also be concluded that when differences between display modes existed, they were generally spread throughout the six different paired display modes. The most statistically significant differences; however, were between zero and non-zero start graphs and between zero start and scale break graphs. Both of these generalized results confirm the previous research done by Kern with non-zero start graphs and Carvalho and McMillans' research on scale break graphs.

To conclude the analysis of all data and to help answer investigative question 10, one-way ANOVAs were conducted on each of the response variables for each of the relevant demographic factors. The files used in the previous analysis were used for this analysis because each file contained one set of responses and demographic data from each of the 180 subjects.

Table 15

Summary of ANOVA Results for Selected Demographic Factors

Demographic Factor	Company Net Asset Size	Loan Decision (Normalized)	Trend Interpretation	Risk Assessment
Age of Subject				
	Large	.1430	.5716	**.0201**
	Medium	.4148	**.0934**	**.0161**
	Small	9069	**.0161**	.2457
Gender				
	Large	**.0125**	.2416	**.0151**
	Medium	***.0070***	.0787	***.0022***
	Small	**.0999**	**.0168**	.1769
Educational Level				
	Large	.7588	.2686	.7743
	Medium	.3827	1526	**.0961**
	Small	.8408	.7436	.2047
Area of Expertise				
	Large	***.0100***	.2436	.5128
	Medium	**.0331**	.2182	.4980
	Small	***.0043***	.0115	.0802
Career Field				
	Large	.1121	.7600	.3668
	Medium	.4547	.9213	6021
	Small	.6881	.2654	.2393
Graphics Training				
	Large	.3917	.1520	.5756
	Medium	.4220	**.0980**	.1929
	Small	.5755	**.0398**	.9590

NOTE: Figures listed in bold print represent p values <= 10
Figures in bold–italic print represent p values <= .01

Table 15 displays the results for the subjects' demographic responses in association with their experiment responses. Analysis was also conducted on the demographic data to determine if there were any personal characteristics that may have affected the outcome of the overall data collected. Figures on this table listed in bold print represent p values less than .10 percent, while figures in bold and italicized represent p values of less than .01 percent.

Some differences in decisions were expected from some of the age categories based purely on personal experiences. Additionally, differences in the decisions made were expected by gender, educational level, area of expertise, career field, and from the subjects with/without graphic training of some type. Table 15 displays that many differences did appear based on all of these selected demographic factors.

Of particular note, however, is that this analysis indicates that the 136 men tested tended to respond differently to the graphs displayed in the experimental packages than the 42 women did (two subjects did not respond to the gender question). This particular piece of information corresponds to results shown in Carvalho and McMillan's thesis which reported the same type of effect on their data outcome. Men tended to respond differently to the broken scale than women did (Carvalho and McMillan, 1992:53).

As an additional note, the subjects were asked to list the software package that they used most often to construct their graphs. Of the subject that used software to construct graphs, the subjects listed *Harvard Graphics* as first, with 65 people selecting it. The next most

popular software package was *Excel* (Microsoft) with 28 of the respondents selecting it as their first choice. The third most popular choice was *Power Point* (Microsoft). Frequency tabulations for all demographic questions may be found at Appendix I.

Summary

Many previous experiments used a pre-test post-test experimental design. These experiments tested only two display modes against one response variable. This experiment was greatly expanded; it included four display modes, three separate response variables, and an additional factor for trend type. These two main factors accounted for differences in the response variables and they also interacted to produce the observed results. A limitation of the pre-test, post-test design is that confounding variables and interaction terms such as trend type and relative company size are not easily analyzed.

Because of time and computer memory limitations, the researchers did not conduct a three-way analysis of variance. This analysis may have provided more insight into the relationship between each of the main effects, the interaction terms, and the response variables.

Analysis of the overall data indicates that there was a difference in the way subjects made decisions using those graphs containing non-zero starts on the dependent Y axis. Additionally, graphs using a fluctuating trend impacted their decisions considerably. The subjects responding to those graphs with scale breaks or tables showed no significant differences in their decision outcomes but did when asked their impressions of the trends. Previous studies by Kern and Carvalho

McMillan indicated these same results with their subjects' impressions.

Although this study does not entirely support the results of previous researchers, it is still very valuable. Like previous research, differences were generally found between the display modes; however, the effect of trend type and relative company size did interact with display mode to blur the differences.

Additionally, the subjects' sex, age, professional experiences and career areas, and educational levels all impacted their responses in this experiment. Formal graph training versus informal training or no training at all also showed significant differences between the responses or decisions of the subjects participating in this experiment.

Chapter 5, Conclusion, contains the summary of all the results as well as recommendations for future research and those areas needing additional experimental work and analysis.

V. Conclusion

The use of pictures to tell a story or capture a snapshot in time, has been going on since the dawn of man on this planet. In modern times, computer created graphics are used to tell the story, or capture like a snapshot, numbers and figures for a multitude of different uses. On a daily basis, someone somewhere is making important decisions using these same computer generated graphics. The possibility that these graphics may misrepresent the data they are trying to portray, grows with their increased usage. Faulty or incorrect decisions costing many thousands of dollars may easily happen if the graphs are drawn incorrectly. The possibility exists that an uninformed user creating incorrect graphs can cause faulty and costly decisions on the part of the decision makers.

Summary of Results

The primary area of interest in this research study is to determine whether decisions based on graphs constructed using a non-zero start, scale breaks, or tabular data are different from decisions based on graphs drawn with zero included on the dependent Y axis. A review of the literature provided answers to seven of the investigative questions posed by this research study. It was found that there are numerous standards for high integrity graphics that have been recommended for use by many different authors over the years. Additionally, many of the recommended standards have not been tested empirically, and therefore lack the basis of proven or tested facts.

In the military or government environments, there are no sanctioned or supported standards upon which the creation of high-integrity graphics can be based. Increasing graph usage for many key government programs brings with it a high possibility of improperly constructed graphs. Therefore the possibility of improperly prepared graphics causing faulty decisions to be made can not be easily ignored.

Several recent studies have tried to test empirically, the use of non-zero starts and scale breaks on the dependent Y axis, in association with the impressions one would have for use in decision making. The use of these two methods of portraying data receive mixed comments from many of the noted authors that have established standards dealing with these areas. There is a fairly even split for those who support non-zero starts and scale breaks with those who do not.

The empirical studies to date have shown that there is an effect on a subject's impression of the underlying data when these two methods are used in contrast to a standard zero start graph. Unfortunately, none of the studies have made the link to an actual decision being made. Instead, they tested the subjects' impressions as they viewed the graphs, not the actual decision or decision outcome.

To make the connection with the actual decision making process and its outcome, an experiment was conducted to determine if decision makers responded differently to data presented in one of four different display modes. One hundred and eighty subjects were tested using an experimental decision package in a pen and paper format. Each subject received a package containing instructions, an example graph or table, a series of three data sets presented in graphical or tabular format

requiring a decision to be made on each, a short questionnaire concerning the subject's impression of the trends/risk depicted by the data sets, and a demographic survey. The packages included a mix of graphs displaying either zero starts, non-zero starts, scale breaks, or the same data in a tabular format.

A Multiple Factor Analysis of Variance (MANOVA) and numerous Analyses of Variance (ANOVAs) were conducted on the experimental results to test the overall null hypothesis that there is no statistically significant differences in decisions made based on any of the four data presentation modes: tabular data, bar graphs starting from zero, bar graphs with scale breaks, and bar graphs starting from a non-zero point. All the tests provided basically the same results; graphs with non-zero starts were interpreted differently when making decisions than those graphs starting at zero on the dependent Y axis, using scale breaks, or data in tabular form. This supports Kern's 1991 study which indicated that graphs starting from a non-zero point on the Y axis influences the impressions of the subjects tested. Additionally, the subject's impressions of the trends are affected by the use of those graphs displaying scale breaks, non-zero starts, or data in a tabular format.

This finding should not lead to the conclusion that non-zero graph starts should never be used. Rather, this could be useful to decision makers that are aware of the effect of a non-zero start on their decisions. Appropriate uses could be found or caveats added to graphs that through necessity, had to start from a point other than zero.

Graph decision responses were analyzed singularly and in groups, as well as against the demographic data responses to determine the

correlation between graph interpretation and the impact each graph had on the actual decision making process. When the data were analyzed as a whole, it was determined that there was generally no significant differences between the responses made based on data portrayed in tabular formats versus the graphical data formats when making actual decisions or assessing risk. Additionally, graphs containing the scale breaks showed no significant differences in response for these two response variables. The most significant differences occurred with the trend interpretation response variable where significant differences were noted between most presentation modes. Overall, the differences noted involved the subjects' impressions of the trends, not during use in actual decision making processes or risk assessment. This result is still in agreement with the findings of Carvalho and McMillan's 1992 research because they did not test scale breaks during actual decisions. Also, neither Kern nor Carvalho and McMillan tested their graphs against data in a tabular format.

Additionally, analyses were conducted by contrasting each of the types of trends displayed on each of the graphs for each of the data presentation methods: increasing, fluctuating, and decreasing. Significant differences were noted with each of the contrasts. The researchers concluded that these differences proved that the subjects were influenced in their decisions primarily by the fluctuating trends, and to a lesser extent by the decreasing trends, across all decision variables.

At this point, it must also be noted that on a number of the experimental packages that tested the tabular data format, subjects

sketched bar graphs next to the data. It would appear that for some of the subjects that a picture was still necessary in their opinion, to adequately interpret the data trend contained in the tabular format.

Also, many of the subjects used percentage calculations in the margins by the graph to analyze the trends of the graphical data. Their calculations interpreted the percentage change of net assets for each of the years displayed in the graphs they were viewing. This means that no matter what type of trend or data presentation method they were viewing, they had the correct percentage change of the net assets upon which they then based their decisions.

The demographic factors associated with each of the subjects' responses were also analyzed to determine if any of these factors contributed to a difference in response or decision making outcome. The sex and age of the subject made a difference, with males responding differently than females, and younger subjects differently than the older subjects. Also, education levels and career concentrations affected the responses and decisions. Those subjects with associate plus responded differently than those with master or doctorate degrees. Subjects with technical or scientific concentrations made decisions that differed from those having managerial or accounting and banking as their career concentrations. Finally, those subjects with formal graph training had different trend impression responses than those with informal or no training at all. This had also been anticipated.

Recommendations for Future Research

Previous research showed that graphs constructed with scale breaks affected decision maker's trend impressions. Other research showed that graphs constructed with a non-zero axis affected the interpretation of the graphics. This research experiment looked at both of these areas in conjunction with tabular data presentation methods and determined that the non-zero axis starts affected decision outcomes more so than any of the other presentation formats. It is not known, however, which of these data presentation methods produce the most accurate interpretation of the data or which is the most preferred format to use. Future research should be conducted to determine what format would produce the best and most accurate presentation method for data used in decision making.

Additionally, many of the demographic factors had significant impacts on the decisions being made by the subjects. If one or all of these factors could be controlled to a far greater extent than was done in this experiment, some of the more confounding variables could be eliminated. Future research could be done in this area, by eliminating some or all of these factors, or producing a controlled experiment that specifically tests for these confounding demographic variables.

Further research could also be done on the magnitude of the lie factor and a decision scenario. Research on the relationship of the two would provide valuable insight into the distortion threshold for graphs in conjunction with actual decision making processes.

Computerizing an entire experiment dealing with some of these research areas would also add another dimension into computerized

decision making and graph presentation formats. Research into this aspect could be conducted to identify the variables associated with computerized decision making. This would also impact many of the newer training courses that the military is launching today, that involve making decisions and choices using a computer based presentation format.

Creating accurate scale breaks with the graphs were difficult at best. Several software packages had to be used to prepare the graphs and then to draw or paint in the scale breaks. Evaluation of these packages or others like them for use in graphics presentations would add another area of research for the future.

Numerous high integrity graph standards as listed in the tables contained within this thesis have not been empirically tested. Any work done in this area would bring standards for high integrity graphs closer to becoming a reality, rather than just a nice-to-know listing that is rarely ever referred to by those who create graphs on a daily basis.

Recommendations

As more research is conducted on the standards for high integrity graphs, more emphasis should be placed on encouraging people who use graphs to make important decisions, to adopt and use these standards. The government and military in particular, should be encouraged to publish these standards in a guide or regulation for future use by all organizations that prepare and use graphs for their decision making processes. The possibility of making erroneous decisions due to bad graphing techniques should be eliminated wherever possible, in order to save the limited resources now available due to enforced economic

hardships. The consequences of faulty decisions made as a result of bad or poorly constructed graphs could be too great to allow this to go unchecked or unguided for too much longer.

The recommended standards should be published in a complete listing available for all users of graphical software packages as a reference manual or guide to proper graph construction. Warnings as to the potential problems and possible misrepresentation of the data contained in the graphs should be clearly marked. Government and military agencies should obtain a copy of the manual as a required guide for all graphical software users or incorporate the guide into official publications or regulations.

Appendix A: Criteria for Construction of High Integrity Graphs

This appendix contains a table containing standards for the construction of high integrity graphs. This table draws heavily from a similar one constructed in Carvalho and McMillan's thesis (1992), since this thesis also deals with the same topic area.

Each standard has been cross referenced with the authors that agree or disagree with that particular standard. An author's agreement with a particular standard is indicated with an "X", while an author's disagreement with a standard is indicated with a "O". Additionally, some authors did not comment on all/some of the reccommended standards and a blank space indicates where that has happened. The authors cross-referenced in the table are as follows:

	Author	Year
1.	Tufte	1983
2.	Taylor	1983
3.	Larkin	1990
4.	Schmid and Schmid	1954
5.	Joint Committee on Standards for Graphic Representation	1915
6.	MacGregor	1979
7.	Steinbart	1986
8.	Johnson, Rice, and Roomich	1980
9.	Spear	1969
10.	Auger	1979
11.	Rogers	1961
12.	American Society of Mechanical Engineers	1979
13.	Lefferts	1981
14.	Cleveland	1985
15.	Schmid	1983
16.	Carvalho and McMillan	1992

CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Charts with an arithmetic scale should begin at the zero baseline.	X	X		X	X	X	X	X	X	X	X	X	X	O	X	X
2. Use multiple scales cautiously.		X		X								X				
3. The dependent axis should employ a simple arithmetic scale						X		X				X				
4. Do not extend the scale much beyond the high or low points on the graph.		X		X							X	X		X		
5. If multiple curves are shown the same unit scale must be used.													X			
6. Use labels to reduce graphical distortion and ambiguity.	X		X	X					X			X				
7. Represent quantities by linear magnitude as areas or volumes may be misinterpreted.	X		X	X	X	X			X							
8. For area graphs, the more irregular strata should be placed near the top.			X													
CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
9. Time scale divisions must be equal.				X		X				X	X	X				
10. The widths in column charts should be the same and spacing equal to one-half the column width.						X			X							
11. Arrange columns systematically.									X		X					
12. If a part of the grid is not needed, use a scale break but keep the origin.						X										O
13. Keep only essential grid lines.	X			X		X					X	X				
14. Each curve on a multiple scale graph should be the same width.						X					X	O				
15. Include spaces for missing periods in time sequences.									X							
16. Avoid scale breaks which give inaccurate impressions.				X						X		X		X		X
CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17. Standard units of monetary measure are better than nominal units.	X															
18. For line charts the total number of plot lines should not exceed five; three or les are better.													X			
19. The simplest curve patterns are the most effective: a solid line is best.												X				
20. Keep charts simple to add to clarity.											X	X	X	X		
21. Do not overdo the number of tick marks.														X		
22. The setup of a graph should be left to right/ bottom to top.			X		X											
23. Graphics must not quote data out of context.	X															X
CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
24. Scale Breaks should be used for false origins.				X	X							X				O
25. Oblong shaped grids should be used rather than square grids.	X															
26. The zero line should be sharply distinguished.				X	X				X							
27. The curve lines should be distinguished from the grid.					X				X		X	X				
28. If a diagram does not include data, it should accompany the chart in tabular form.					X						X	X				
29. If shading, shade from the zero line to the curve.									X							
30. Vertical or horizontal shadings not recommended.									X			X	X			
31. Patterned shadings should be of good contrast.				X		X				X	X	X				
CRITERIA	AUTHORS: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Appendix B: Experiment Scenario

This appendix contains the experiment package scenario used to conduct decision making experiment. Refer to Appendices C, D, or E for the remainder of the experiment package. The scenario placed the subjects as loan officers about to make a loan from a bank to a fictitious local company. It gave detailed instructions on how the subjects were to proceed through the experiment package. It also provided the subjects with a sample decision package; a working example to help reinforce the instructions.

Both sets of instructions contained in the graph and table packages were nearly identical with the exceptions being as follows: the word "graphs" was replaced with "tables" in the text and the graph of company X's net assets was replaced by a table depicting Company X's net assets. A fluctuating net assets trend was used because the authors felt it would be the most difficult trend to visualize based on the instructions. The authors felt this example would put all of the subjects on common ground.

AN EXPERIMENT IN DECISION MAKING

EXPERIMENT PACKAGE

Jeanne E. Tennison, M.S.A.
Major, USAF

Phillip G. Puglisi, M.B.A.
Captain, USAF

INSTRUCTIONS

The purpose of this experiment is to obtain empirical data concerning the relationship of graphs to decision making. You are asked to assume the role of a senior loan officer for a bank. Once a company is approved for a loan, your job is to determine the amount. Your decision is based solely on the four-year trend in the net assets of the company requesting the loan. The bank's board of directors has developed the following decision chart to determine the loan amount:

Trend in Net Assets	Amount of Four-year Loan (Percent of 1992 Net Assets)				
Decreasing	15	20	25	30	35
Fluctuating	40	45	50	55	60
Increasing	65	70	75	80	85

If the trend in net assets is decreasing, then the amount of the loan is from 15 to 35 percent of the company's 1992 net assets. If the trend in net assets is fluctuating (neither consistently increasing nor decreasing), then the amount of the loan is from 40 to 60 percent of the company's net assets. If the trend in net assets is increasing, then the amount of the loan is from 65 to 85 percent of the company's net assets. For this experiment, "net assets" is defined as the difference between a company's assets and liabilities.

Based on your assessment of the **significance of the trend in net assets**, indicate the amount of the loan by circling the appropriate number in the decision table beneath the graph. In this experiment you will be deciding the loan amounts for three companies. Each company is independent of the others. You will have three minutes to determine the loan amount for each company. Do not turn to a new page until told to do so. Do not turn back to review or change a previous answer. Please do not talk to others during the experiment.

An example is provided on the next page. Based on the data depicted in the graph, determine the direction of the trend in net assets (decreasing, fluctuating, increasing) and indicate the amount of the loan. There are no right or wrong answers. You will be given a chance to ask questions before starting the actual experiment.

Thank you in advance for participating in this experiment.

STOP!

Please do not continue until told to do so.

INSTRUCTIONS

The purpose of this experiment is to obtain empirical data concerning the relationship of tables to decision making. You are asked to assume the role of a senior loan officer for a bank. Once a company is approved for a loan, your job is to determine the amount. Your decision is based solely on the four-year trend in the net assets of the company requesting the loan. The bank's board of directors has developed the following decision chart to determine the loan amount:

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Fluctuating	40	45	50	55	60
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Based on your assessment of the **significance of the trend in net assets**, indicate the amount of the loan by circling the appropriate number in the decision chart beneath the table. In this experiment you will be deciding the loan amounts for three companies. Each company is independent of the others. You will have three minutes to determine the loan amount for each company. Do not turn to a new page until told to do so. Do not turn back to review or change a previous answer. Please do not talk to others during the experiment.

An example is provided on the next page. Based on the data depicted in the table, determine the direction of the trend in net assets (decreasing, fluctuating, increasing) and indicate the amount of the loan. There are no right or wrong answers. You will be given a chance to ask questions before starting the actual experiment.

Thank you in advance for participating in this experiment.

STOP!

Please do not continue until told to do so.

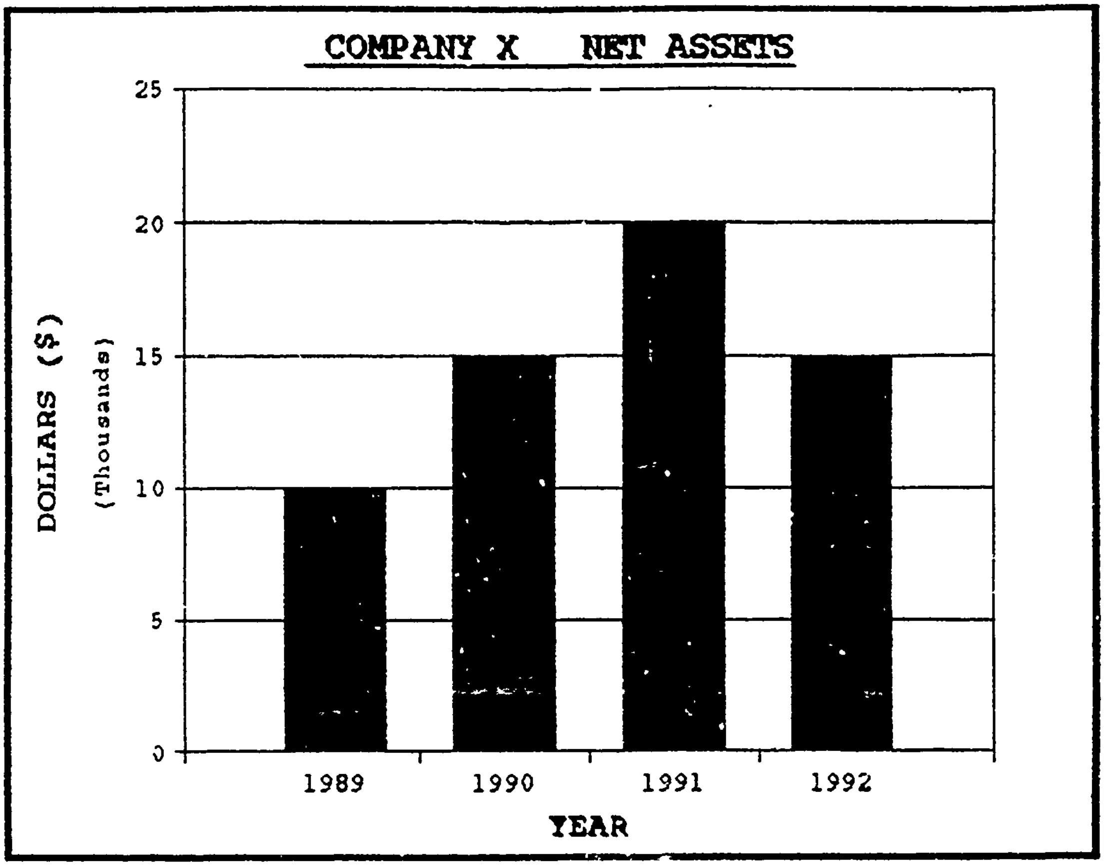
SAMPLE DECISION PACKAGE

Company X has requested a loan from your institution. The graph depicting company X's net asset performance for the past four years is shown on the next page. The loan has been approved; it is your job to decide the <u>amount</u> of the loan based on the net asset trend and the limits provided by the board of directors.

Since Company X's net assets fluctuated over the last four years, they are eligible for a loan in the range of 40 to 60 percent of their 1992 net assets. On the chart below the graph you will find that 55 percent has been circled. This number represents the percentage amount that we are intending to loan Company X. Please note that this figure falls within the range specified by the bank's board of directors for a firm with fluctuating net assets. The percentage selected is based solely on how you feel the company is doing by looking at the trend in their net assets graph. You may decide to chose a lower or a higher figure than we selected in this example.

As you view each of the graphs contained in this package, keep in mind that the percentage you circle should be based on how you feel the company is doing by looking at their four year trend in net assets.

CONTINUE ON TO THE NEXT PAGE.



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	15	20	25	30	35
Fluctuating	40	45	50	55	60
Increasing	65	70	75	80	85

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

SAMPLE DECISION PACKAGE

Company X has requested a loan from your institution. The table depicting company X's net asset performance for the past four years is shown on the next page. The loan has been approved; it is your job to decide the amount of the loan based on the net asset trend and the limits provided by the board of directors.

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As you view each of the tables contained in this package, keep in mind that the percentage you circle should be based on how you feel the company is doing by looking at their four year trend in net assets.

CONTINUE ON TO THE NEXT PAGE.

COMPANY X NET ASSETS

1989	$10,000
1990	$15,000
1991	$20,000
1992	$15,000

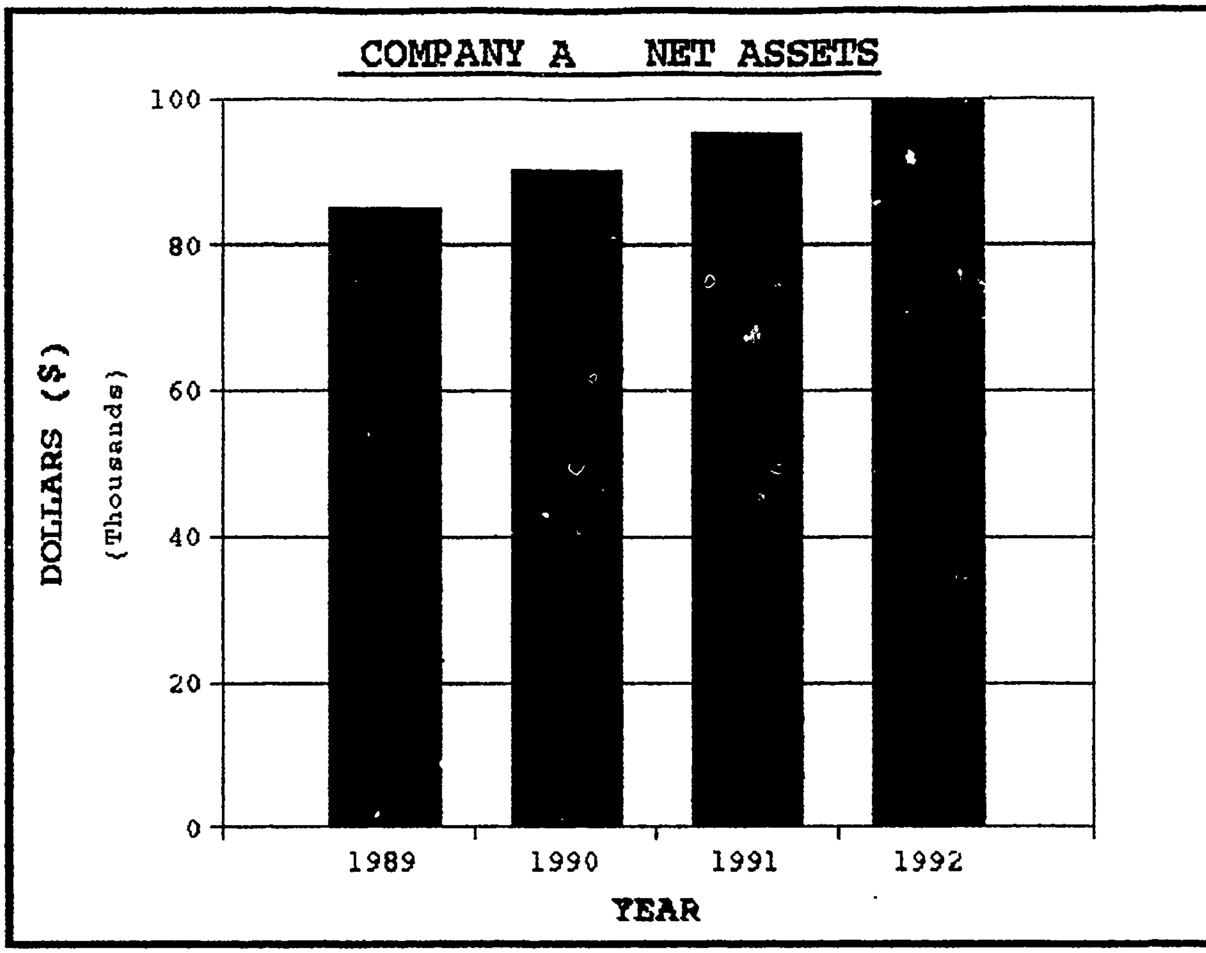
Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

Appendix C: Experiment Graphs and Tables

Appendix C contains a complete listing of all the graphs and tables used in the experimental packages viewed by all 180 subjects. Each of the graphs and tables are presented in the alphabetical order of the company. This does not necessarily represent the order in which the subjects may have received the package, since the graphs were assembled in a random order as to not prejudice the data being collected.



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

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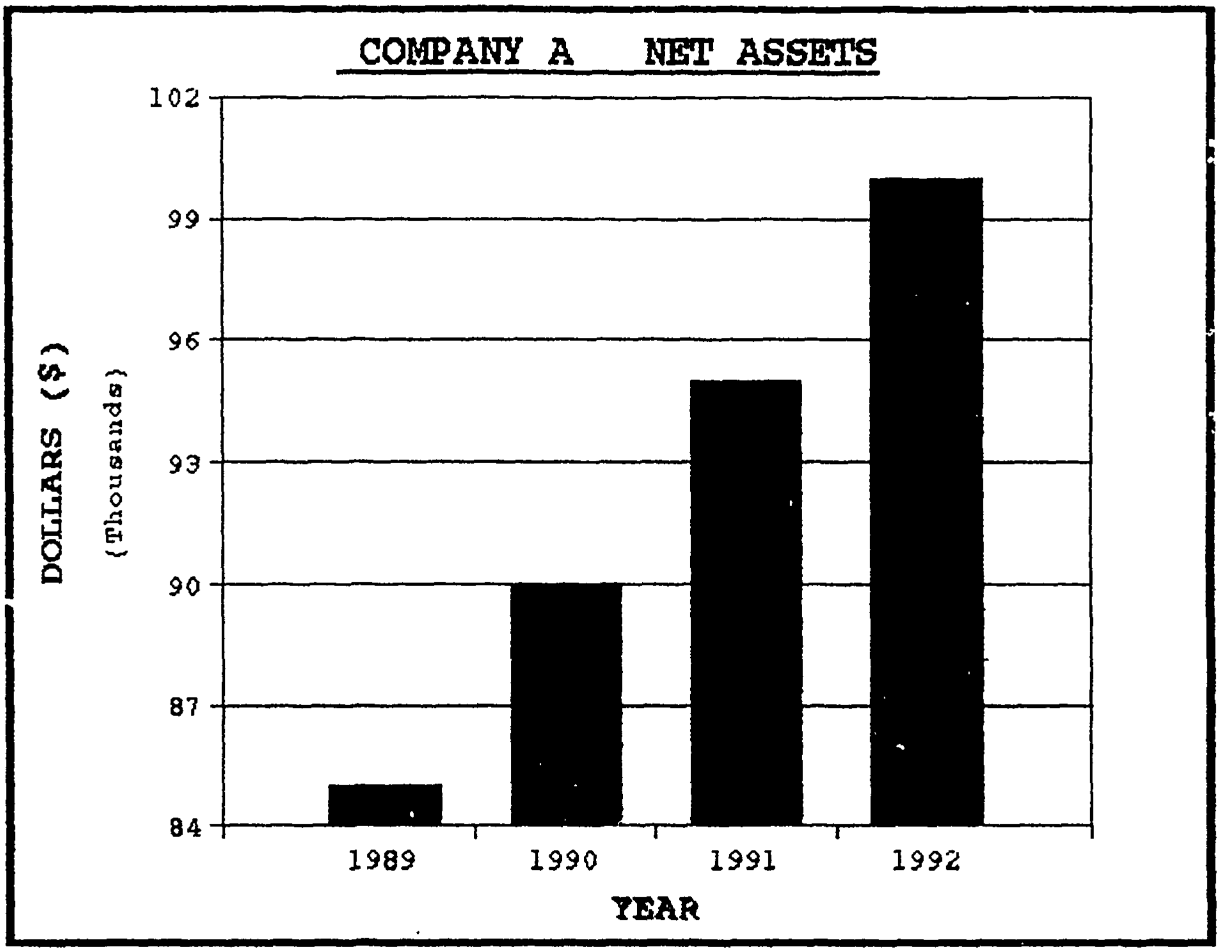

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

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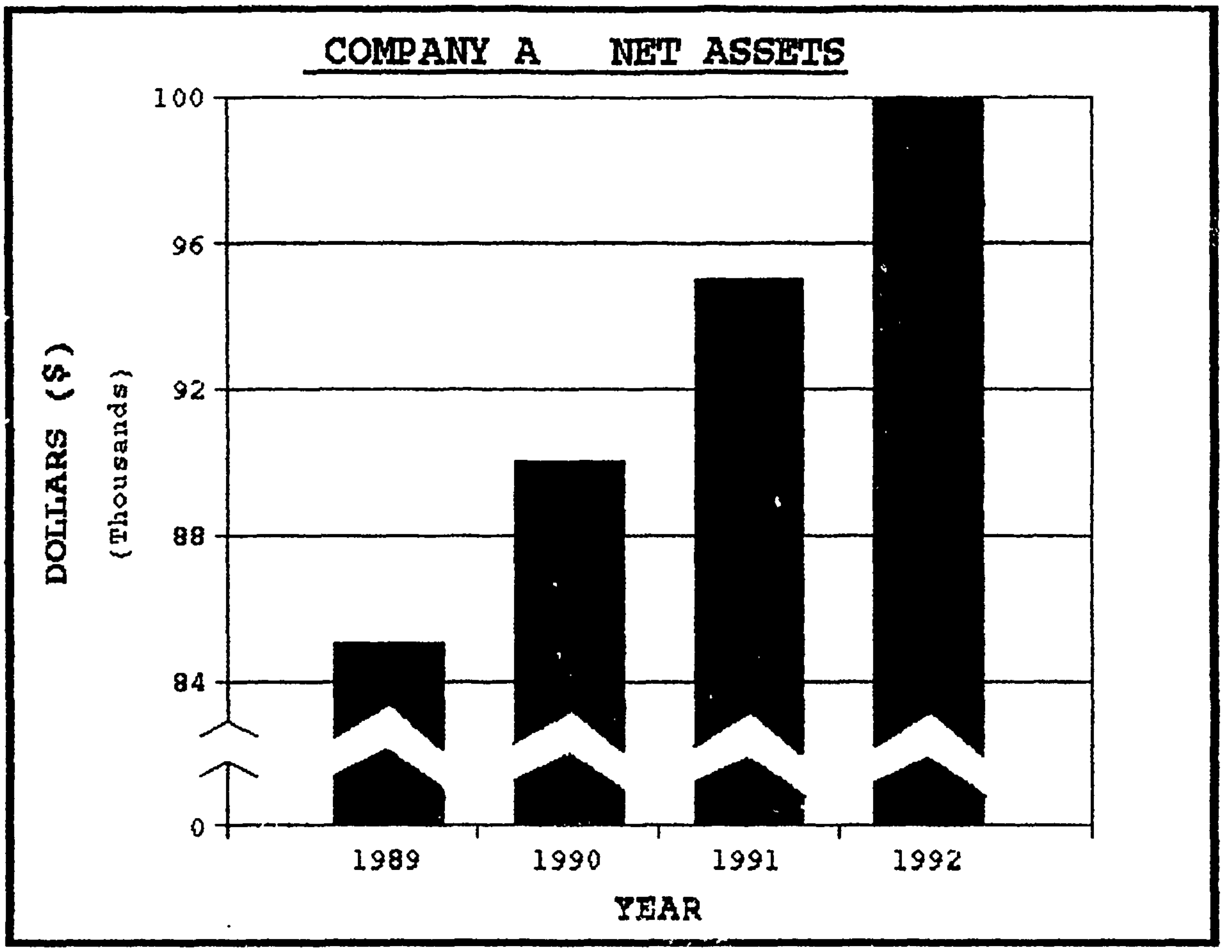

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
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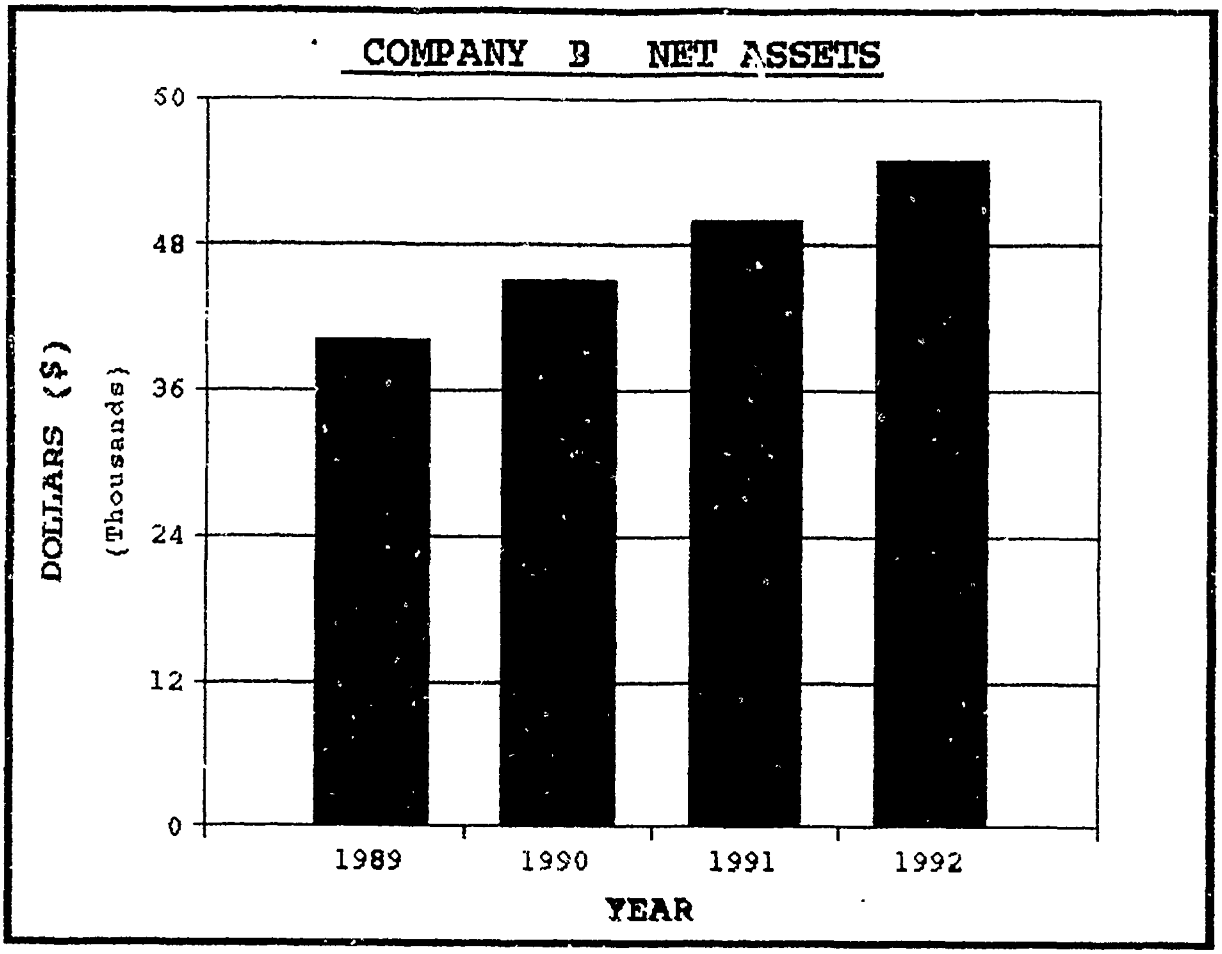

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

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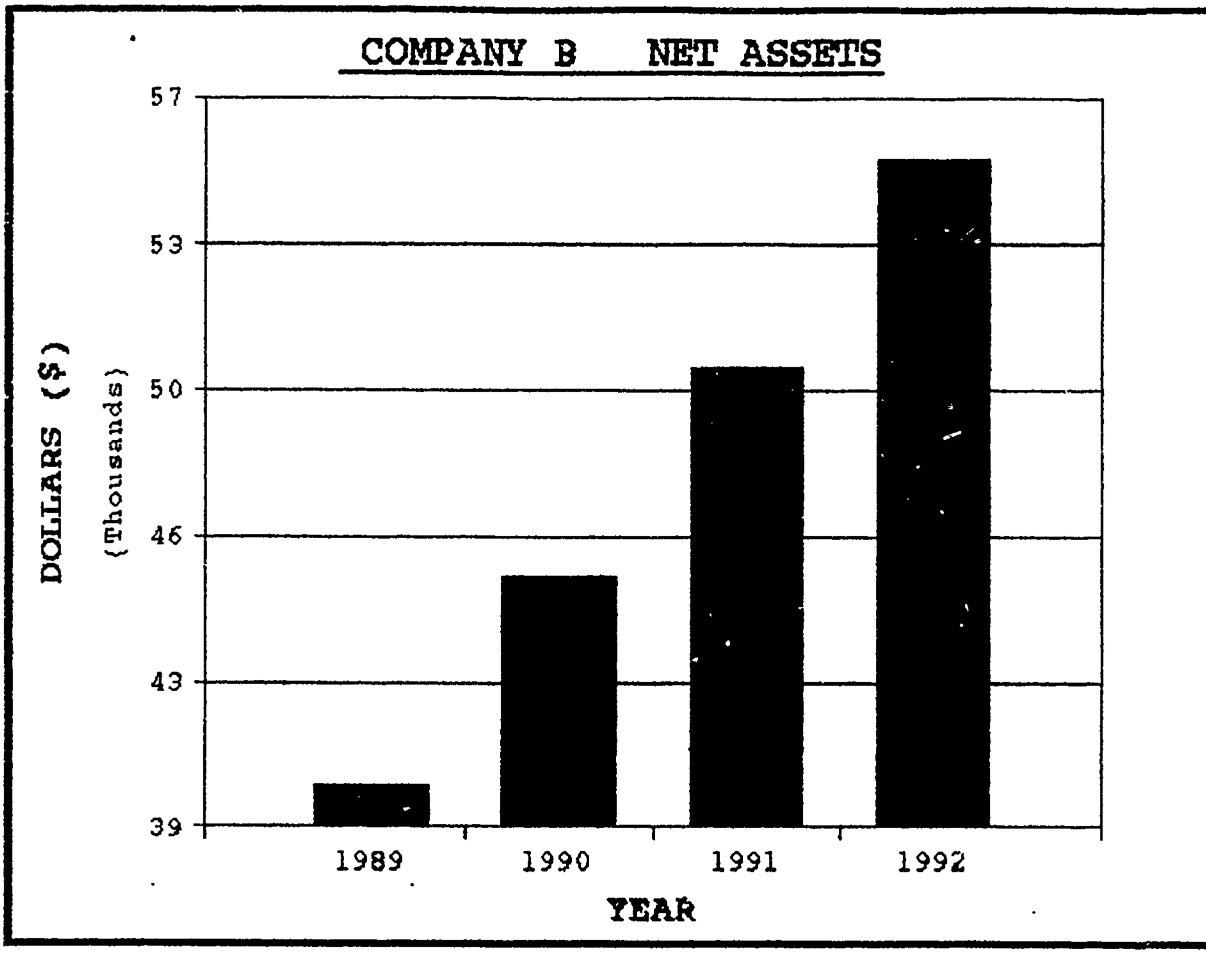

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
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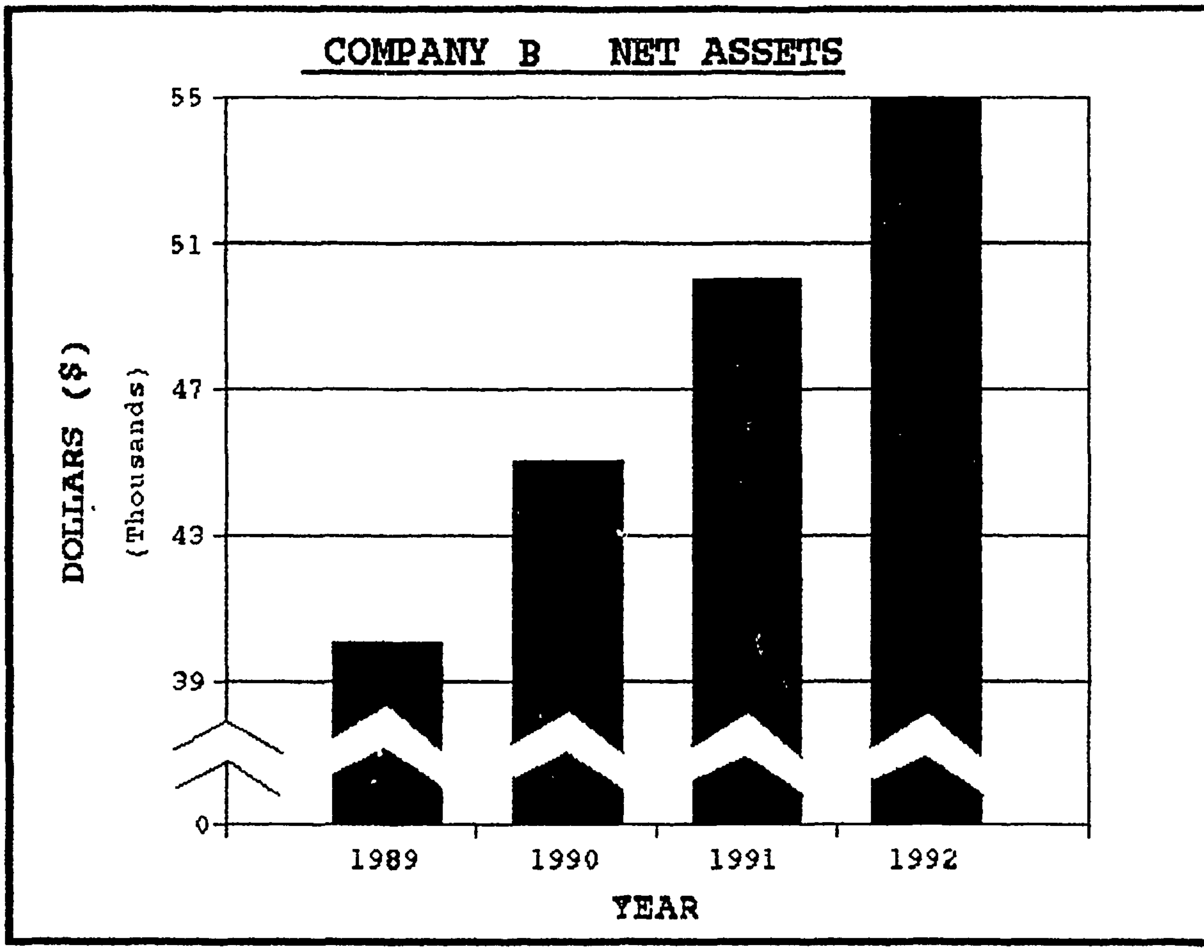

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
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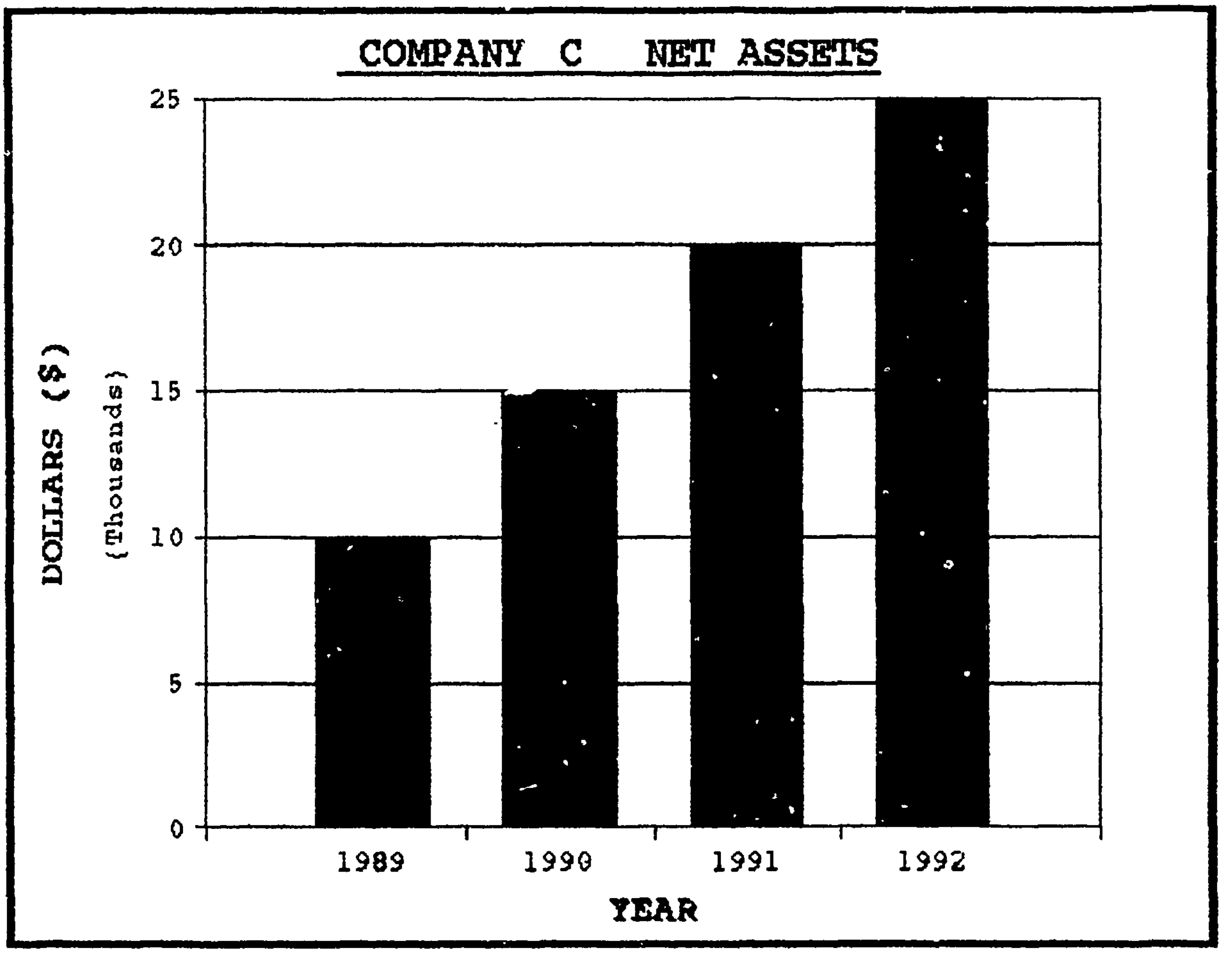

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
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Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

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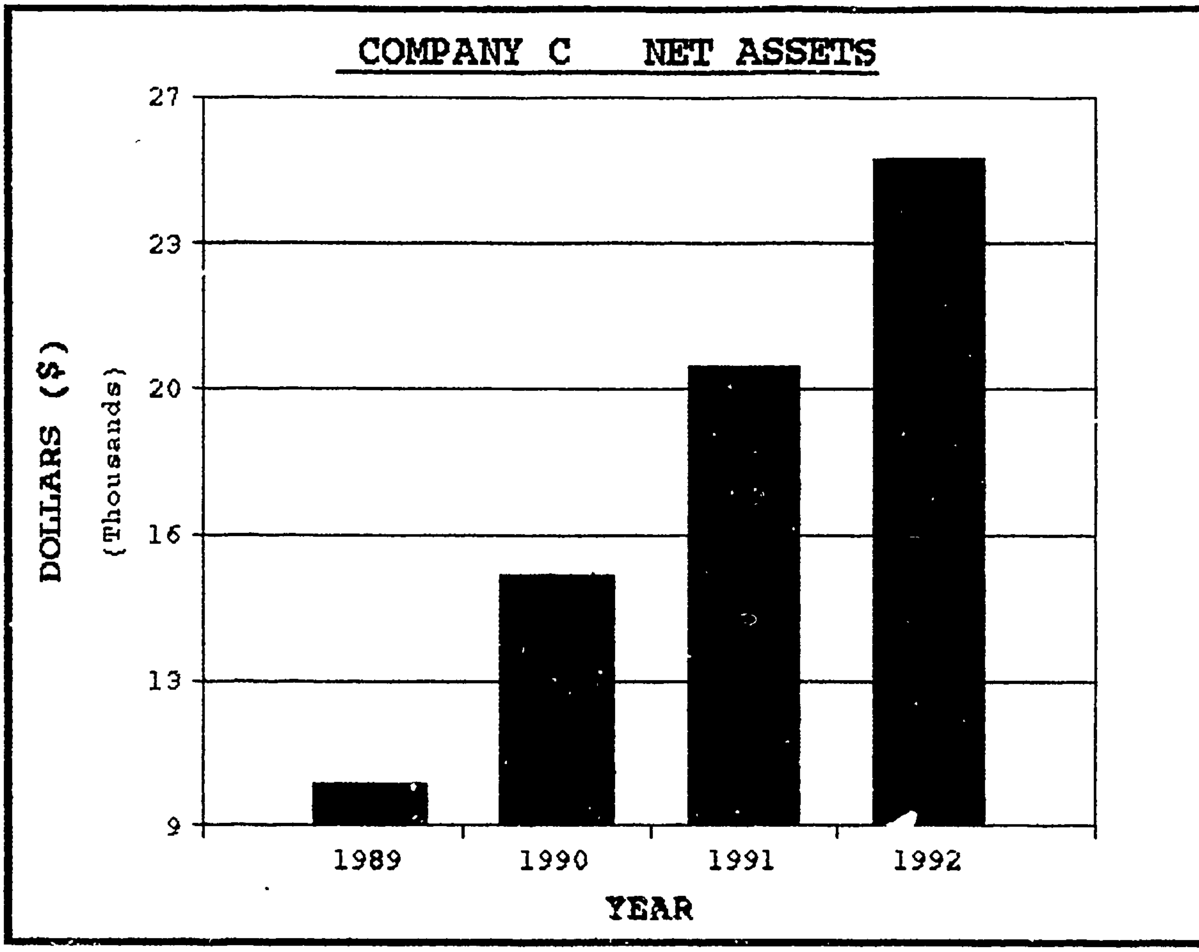

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	15	20	25	30	35
Fluctuating	40	45	50	55	60
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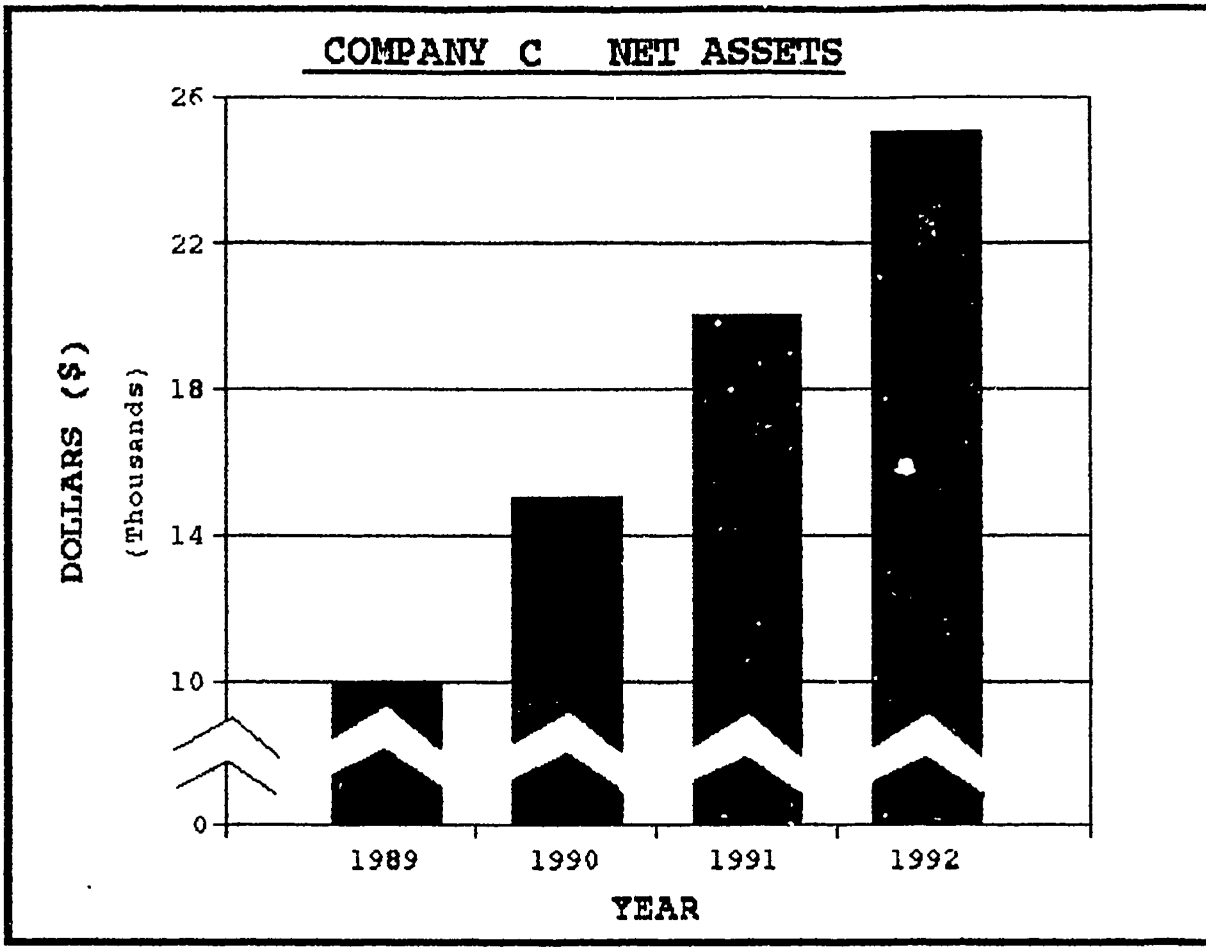

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
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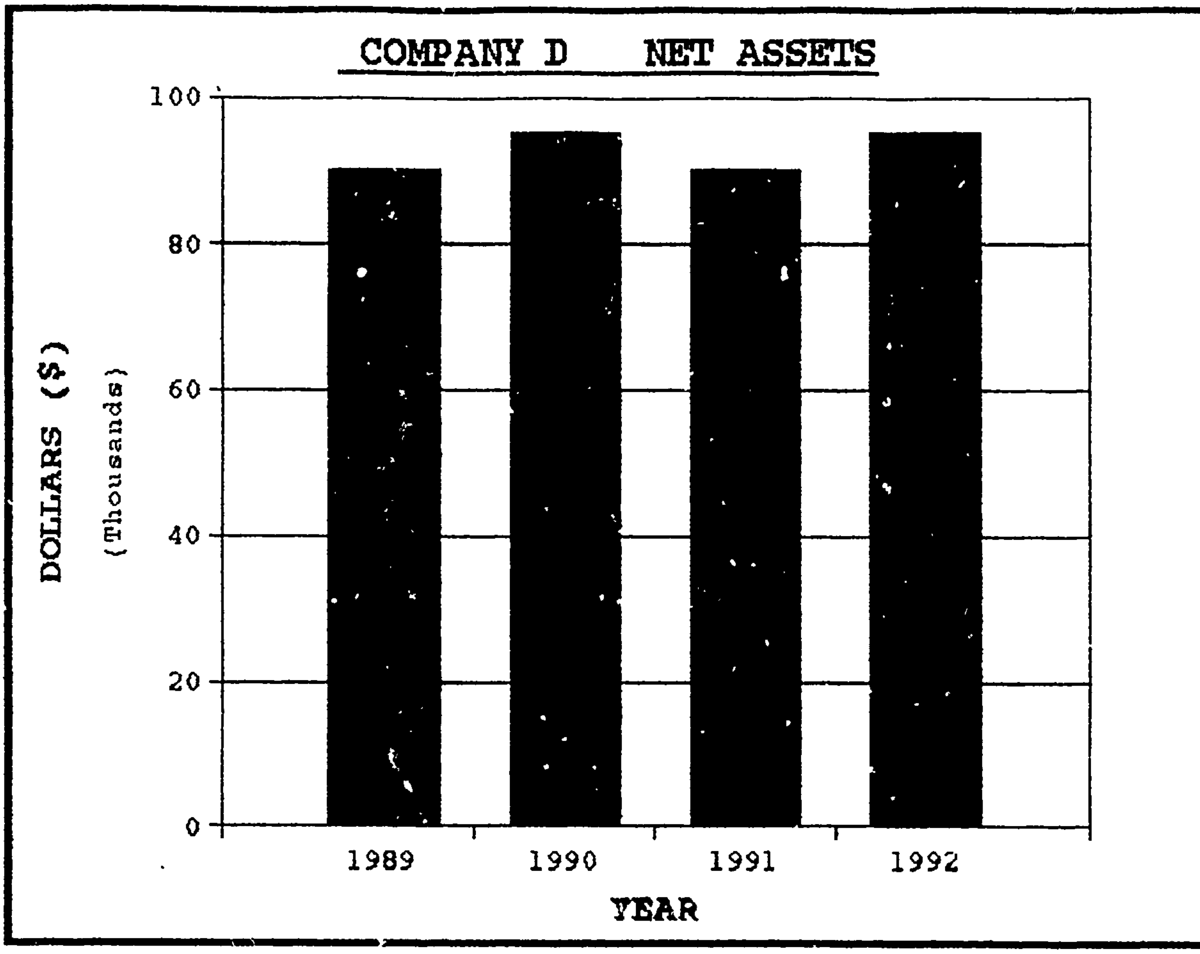

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
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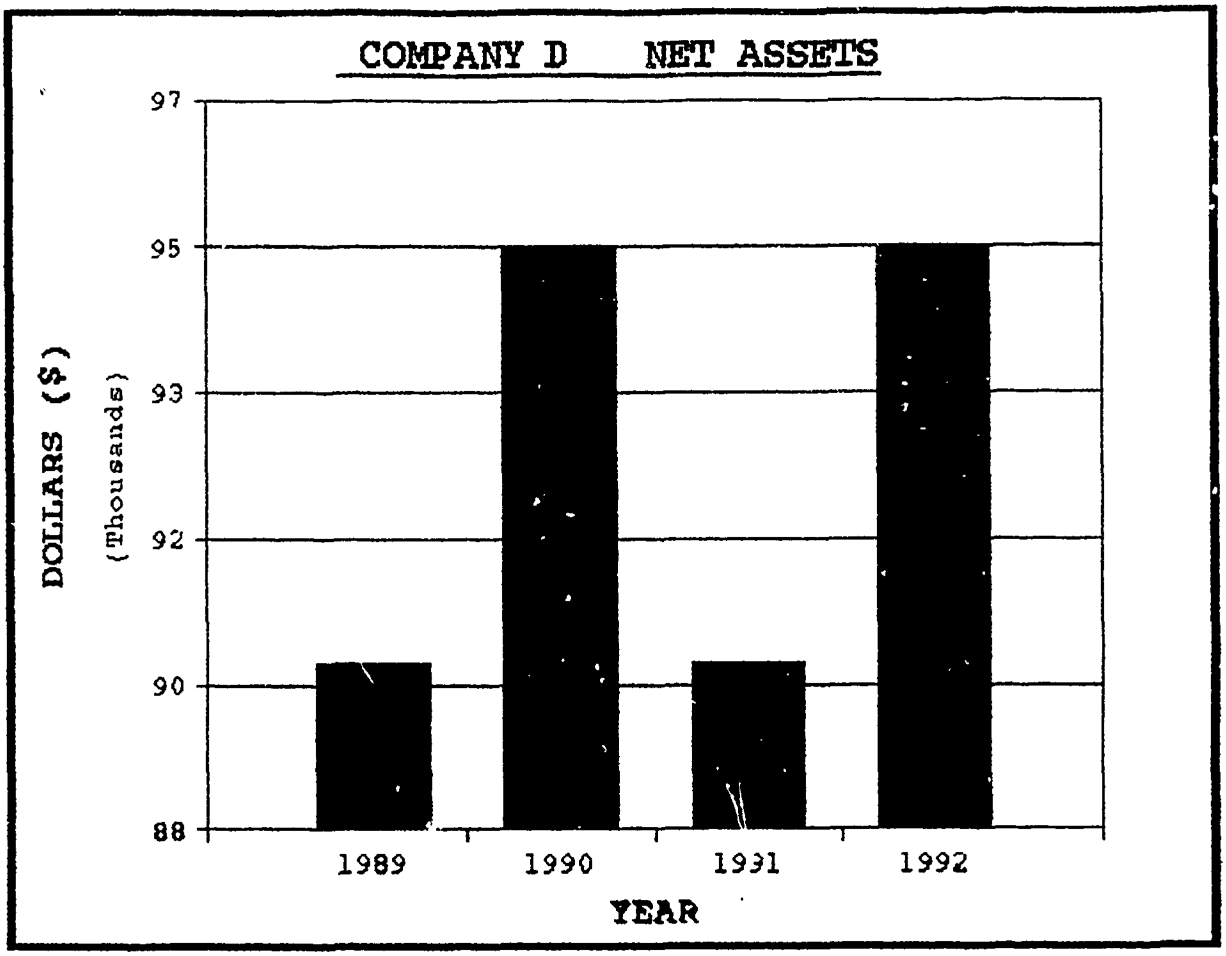

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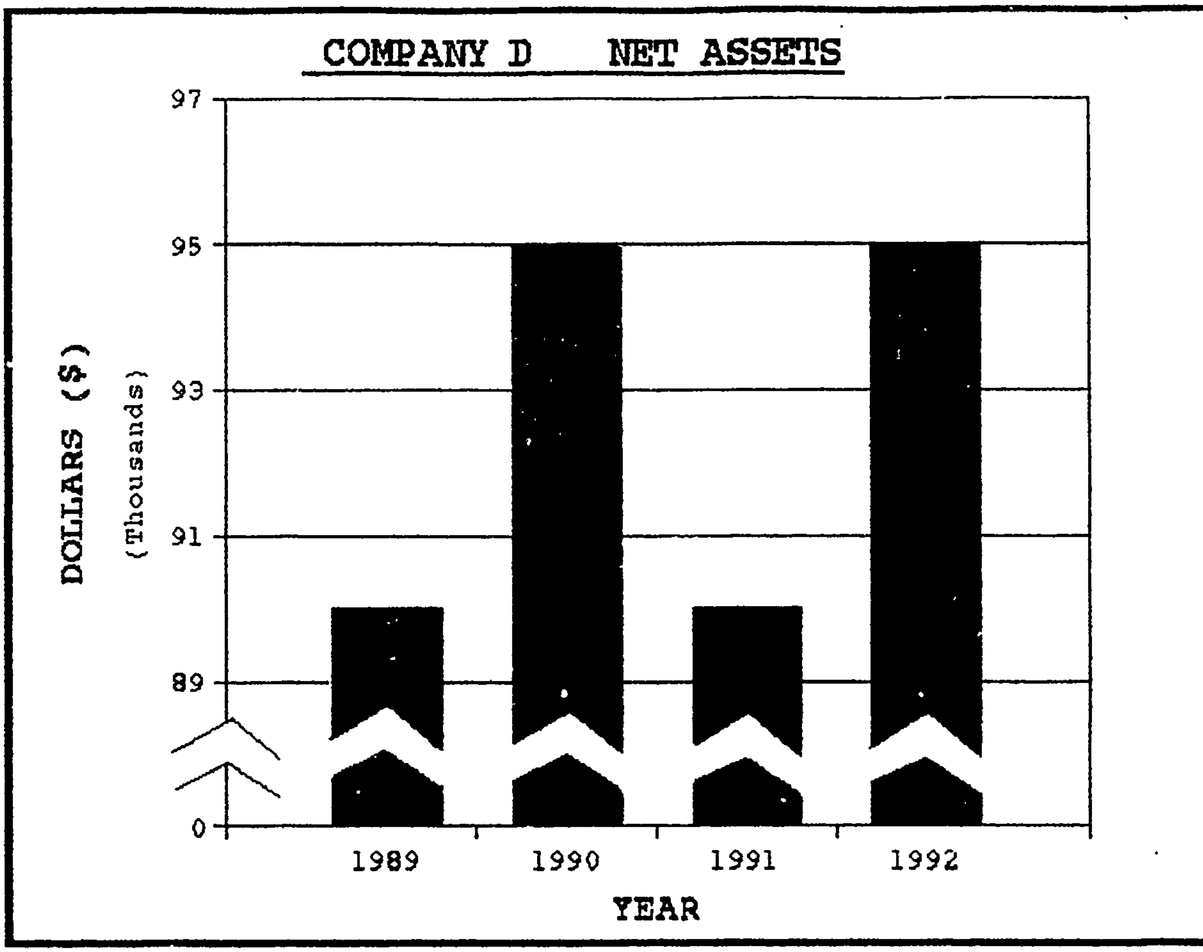

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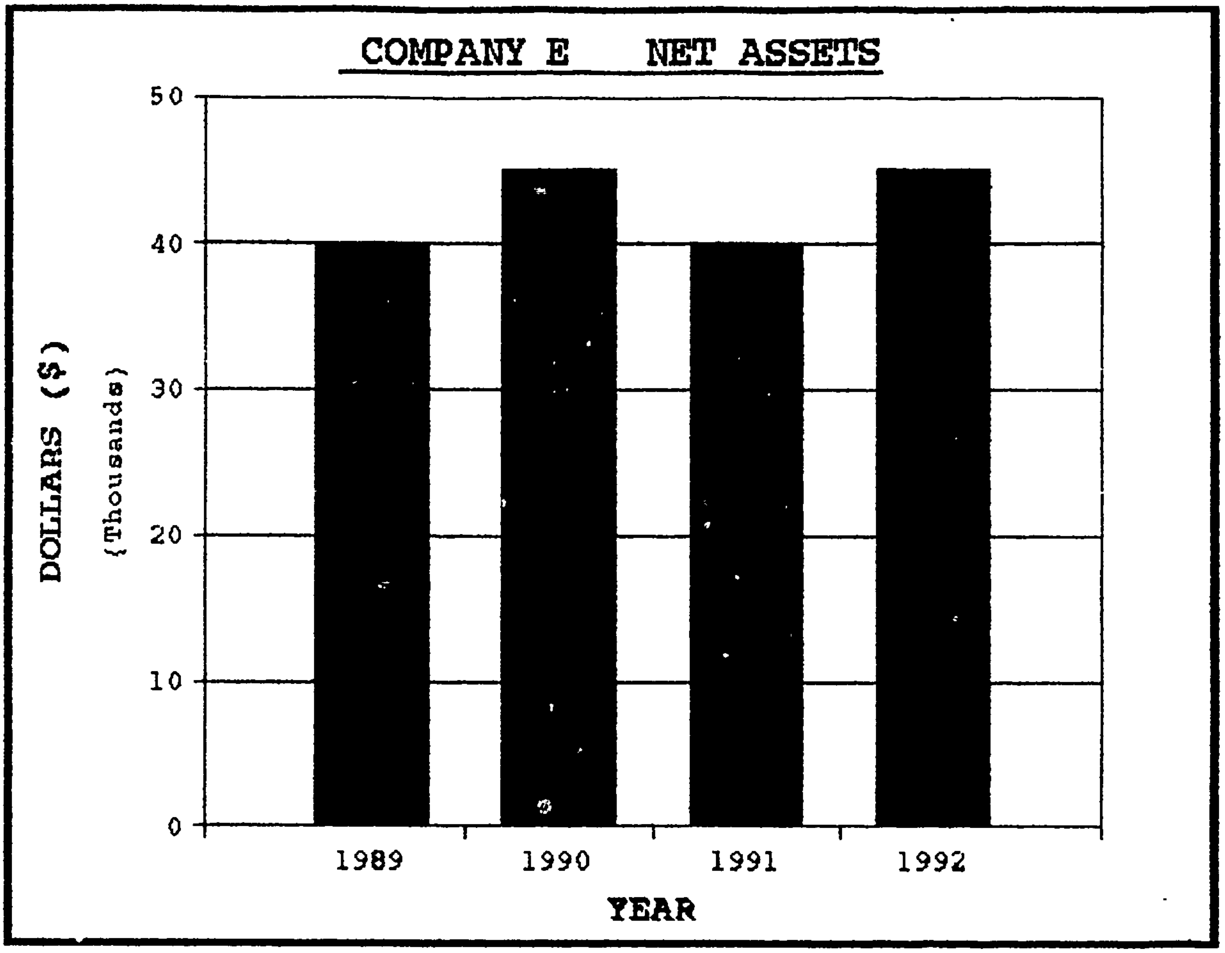

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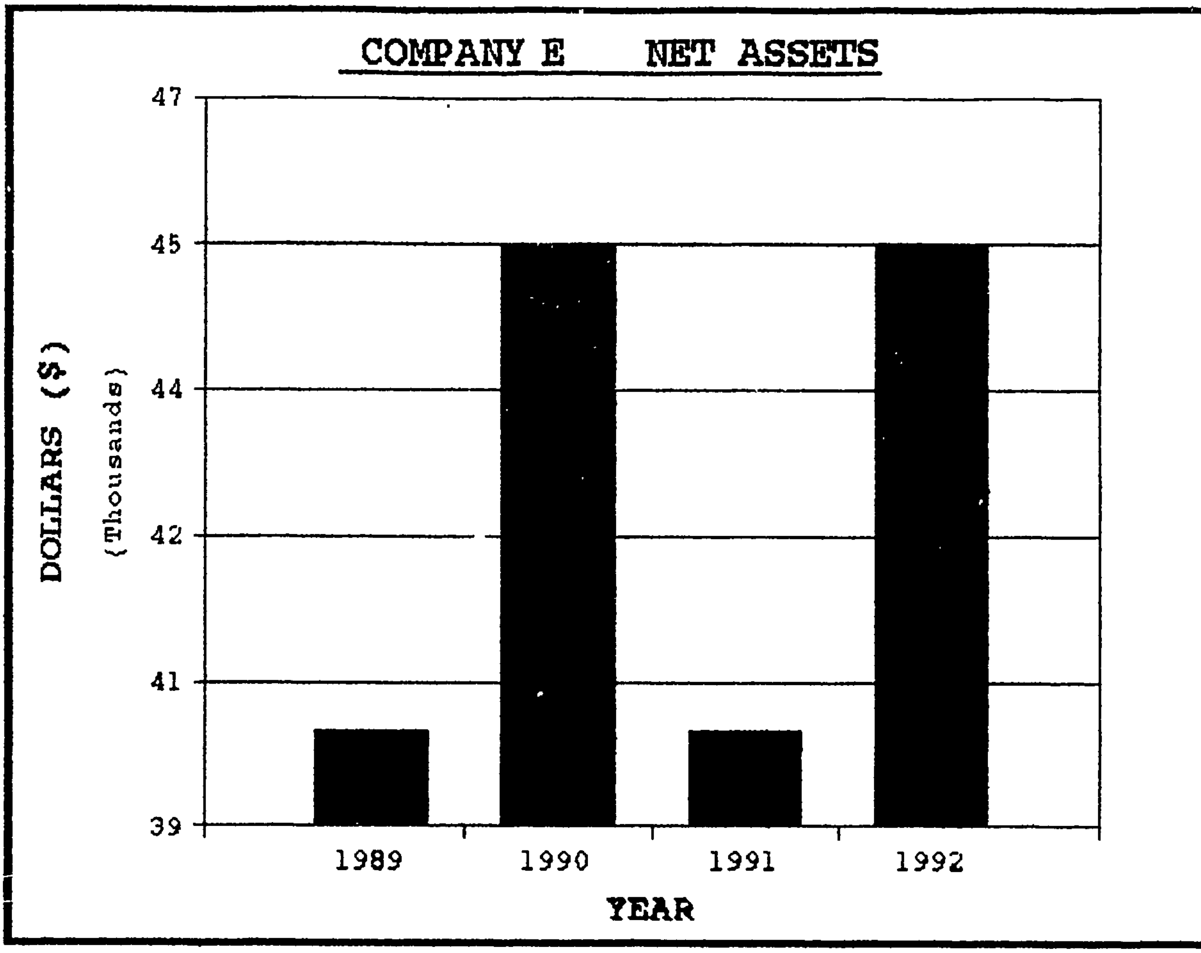

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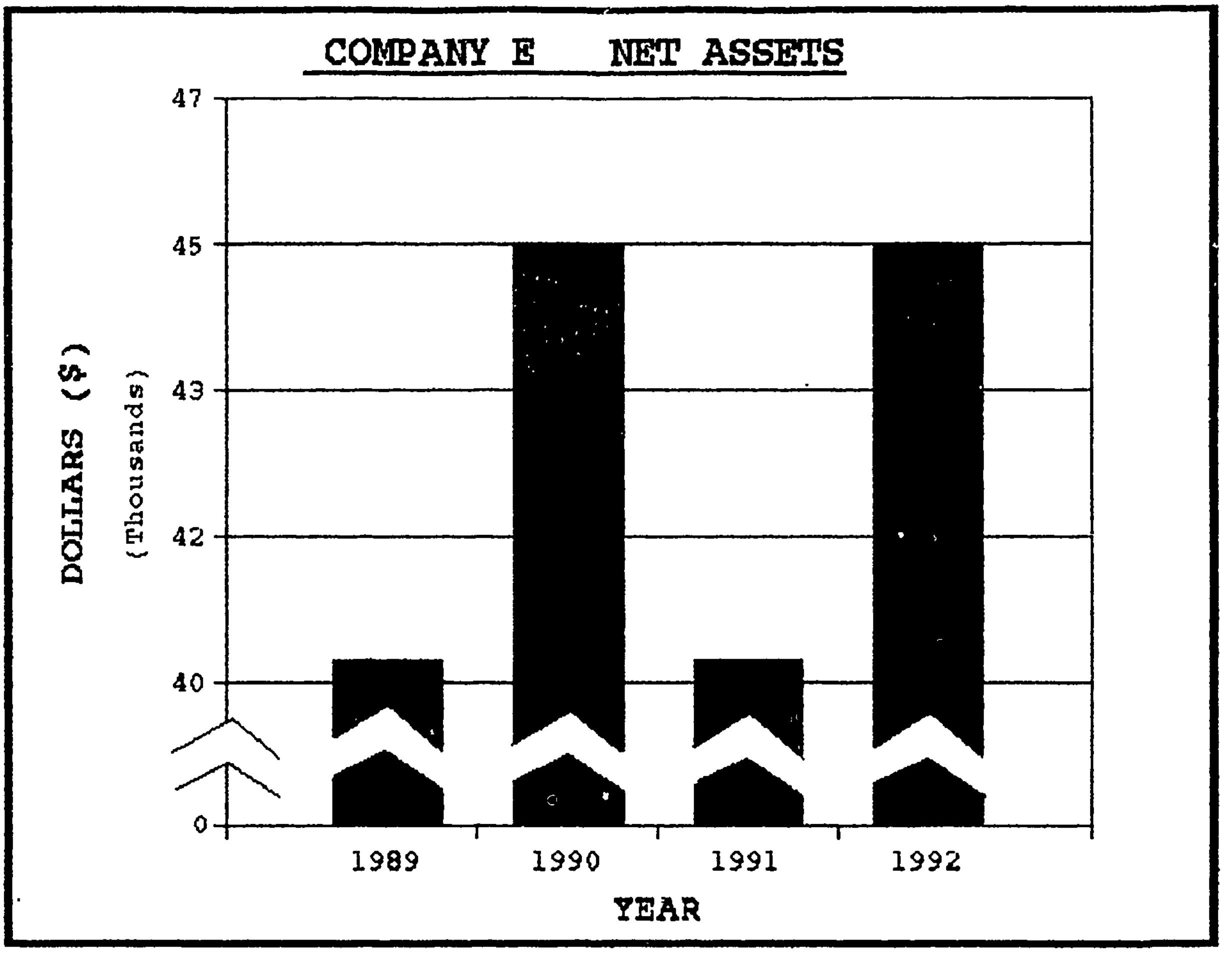

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
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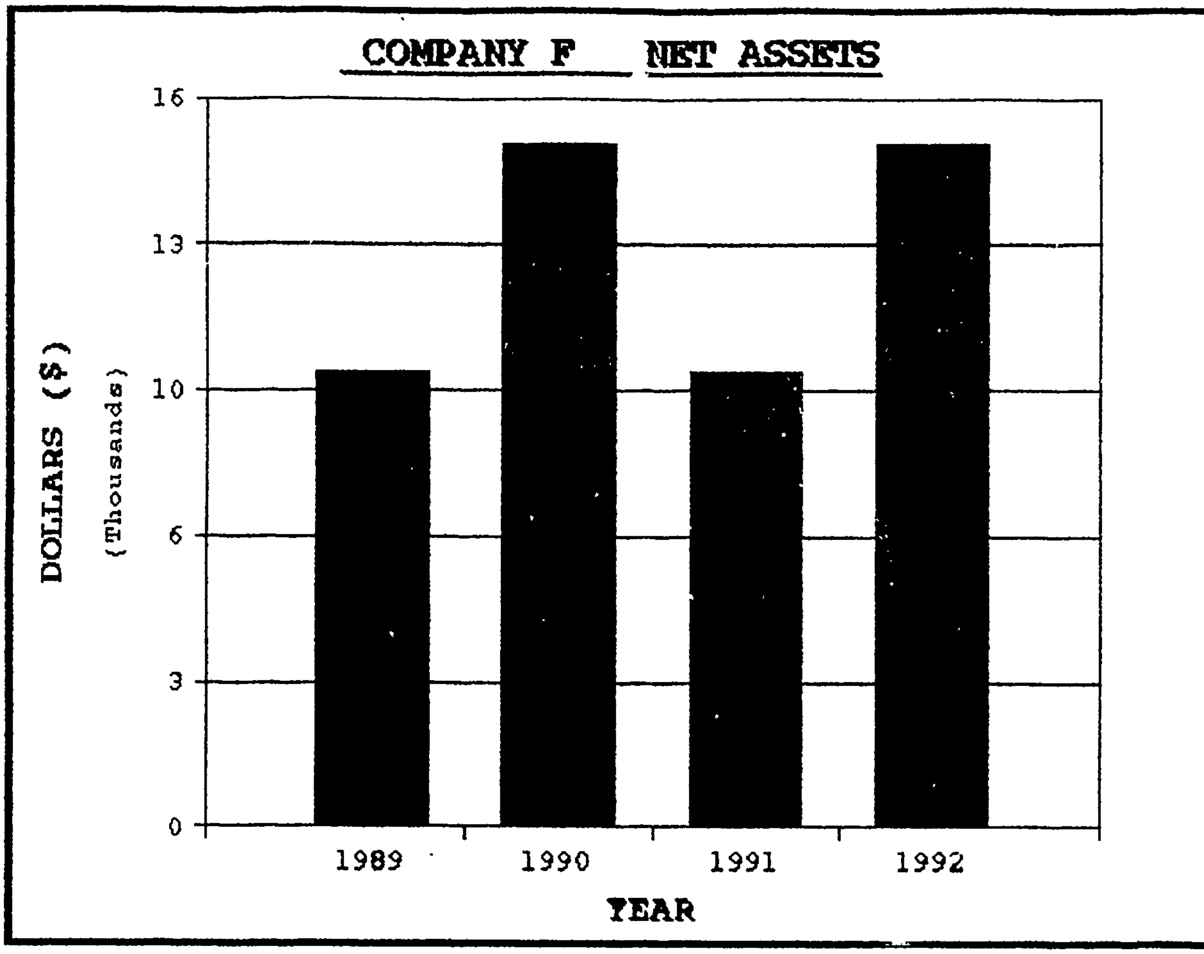

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Decreasing	**15**	**20**	**25**	**30**	**35**
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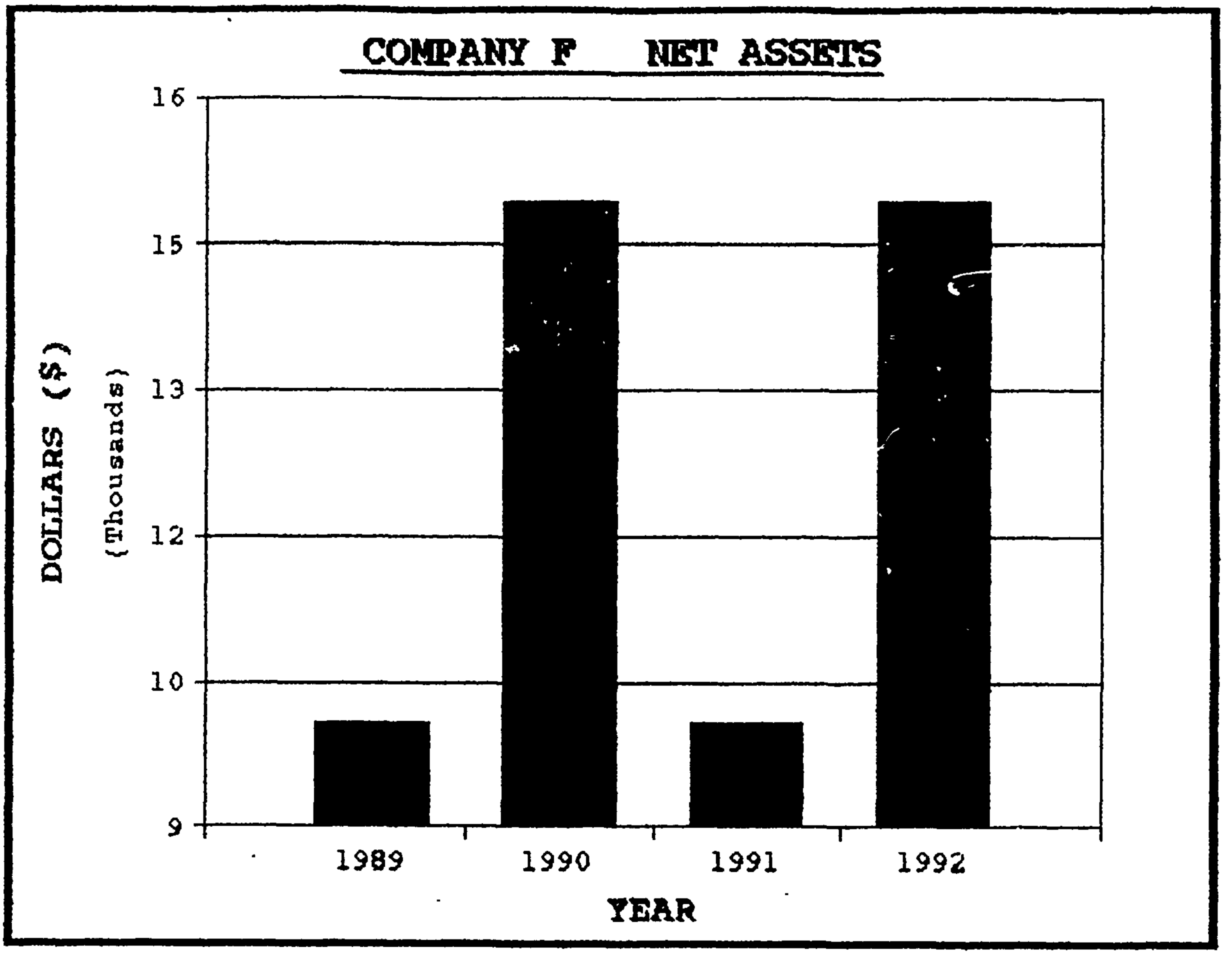

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

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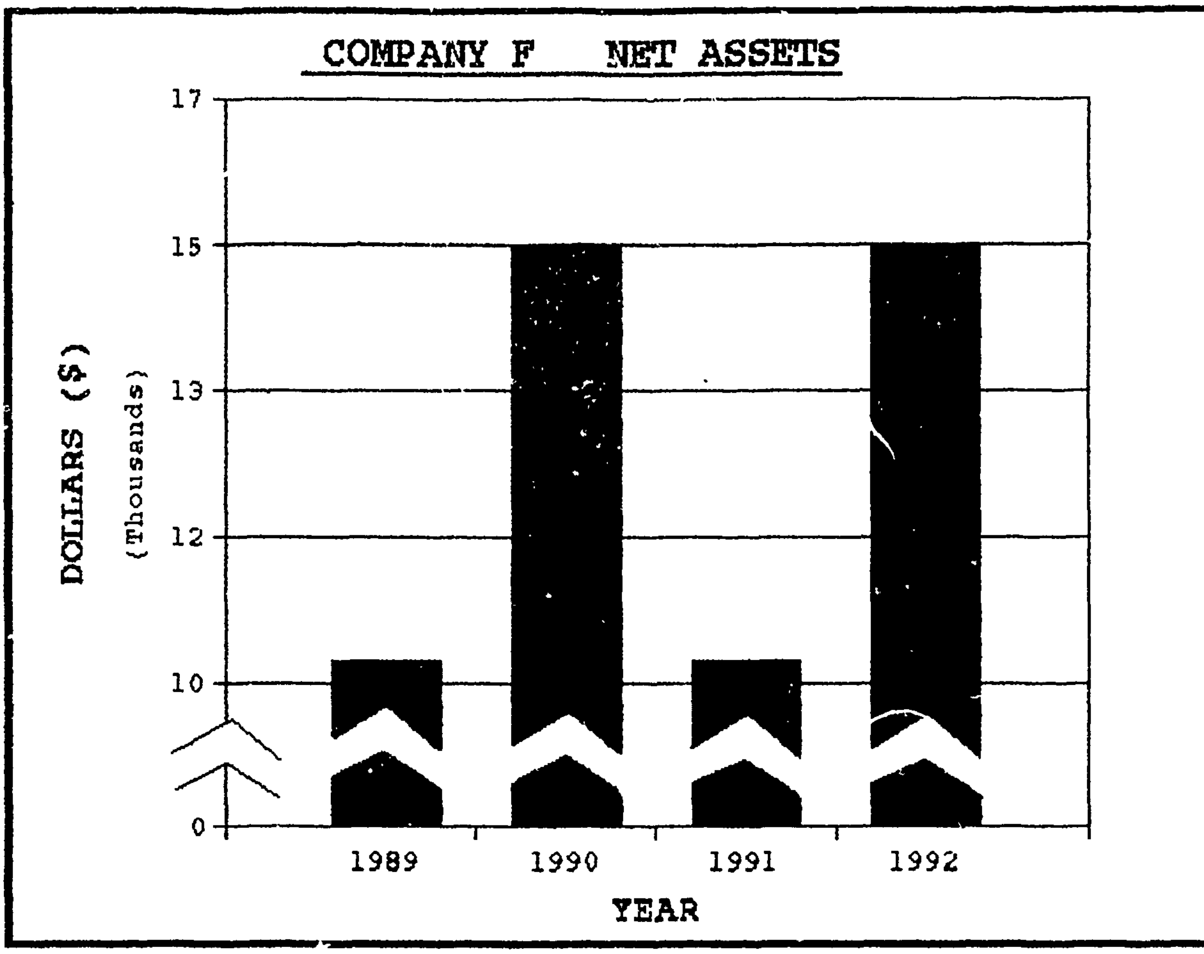

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
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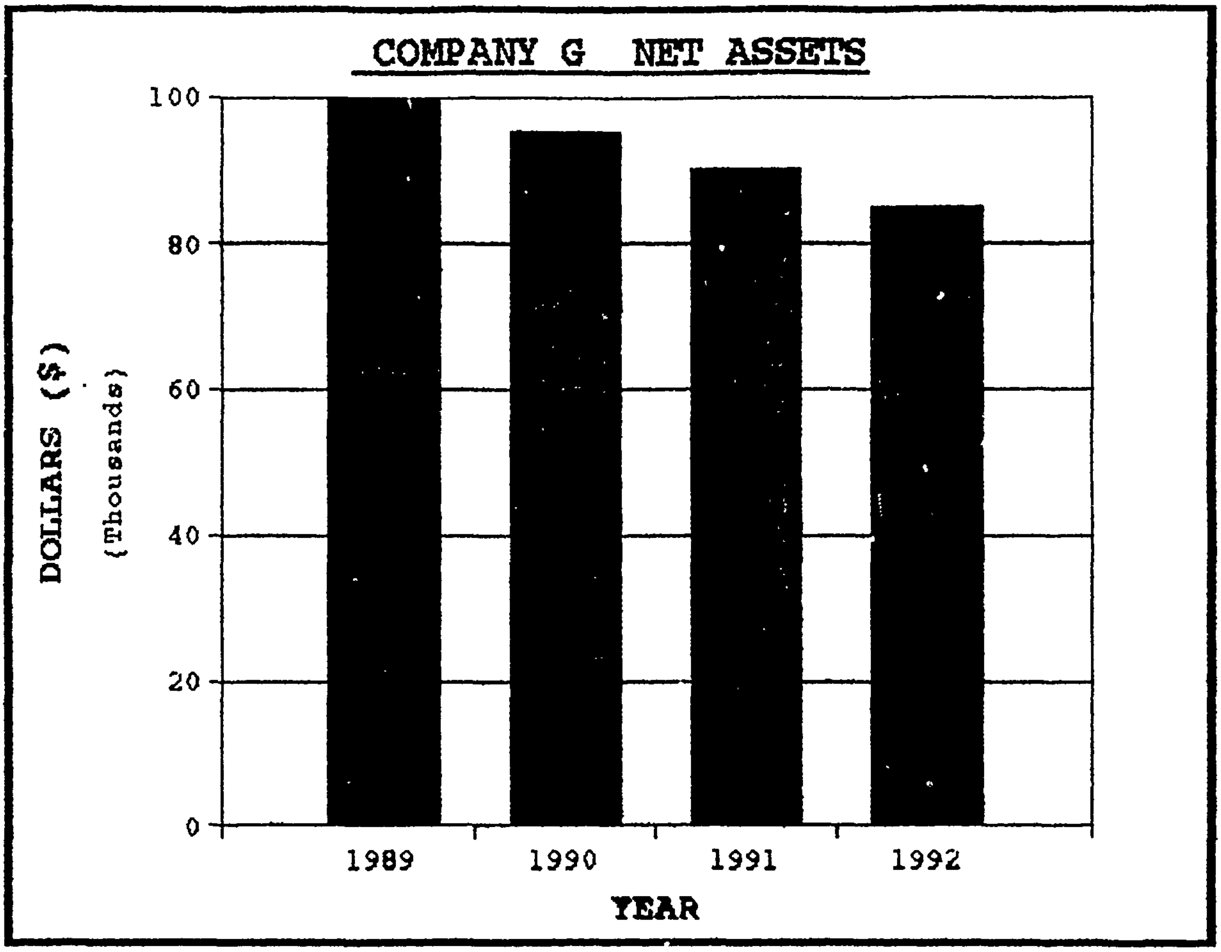

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
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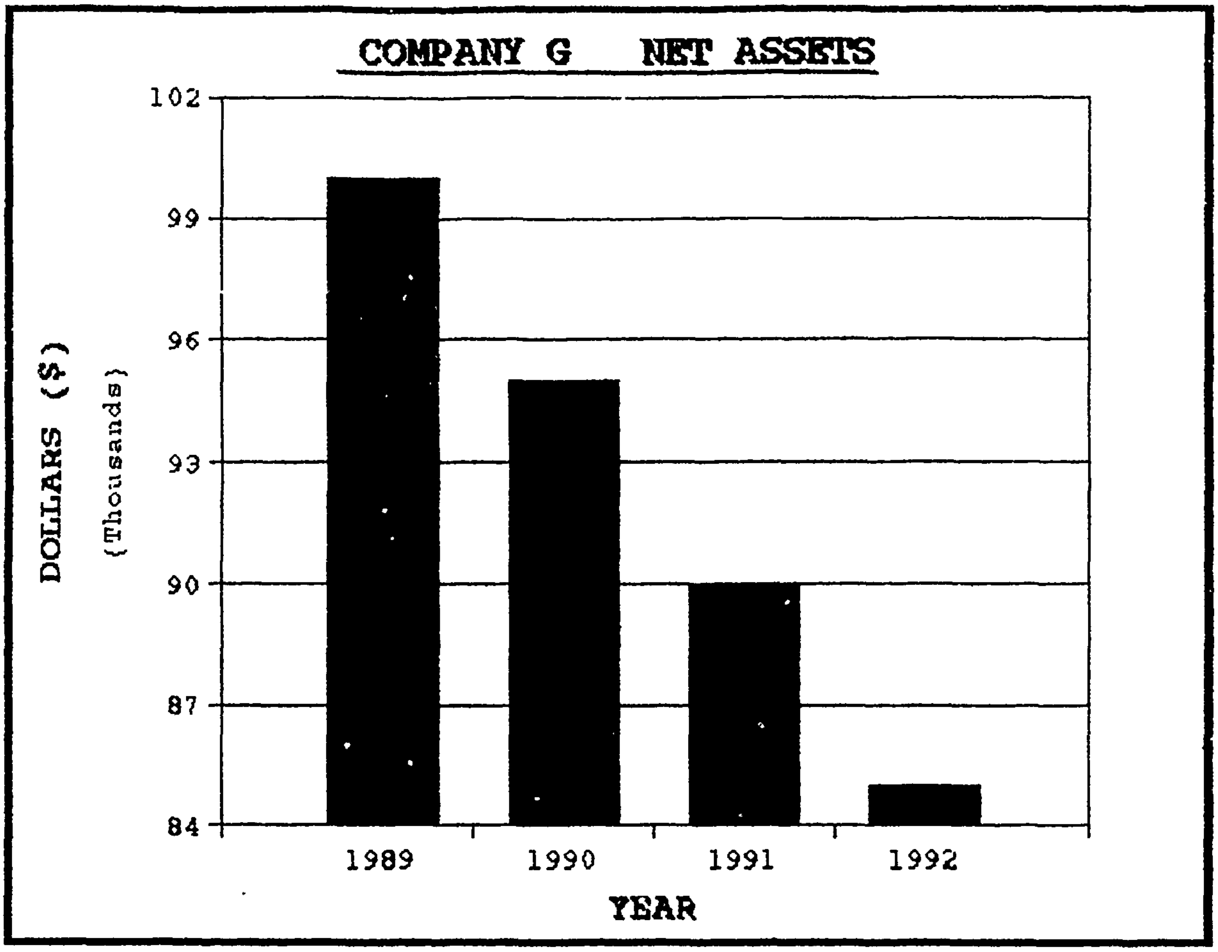

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	15	20	25	30	35
Fluctuating	40	45	50	55	60
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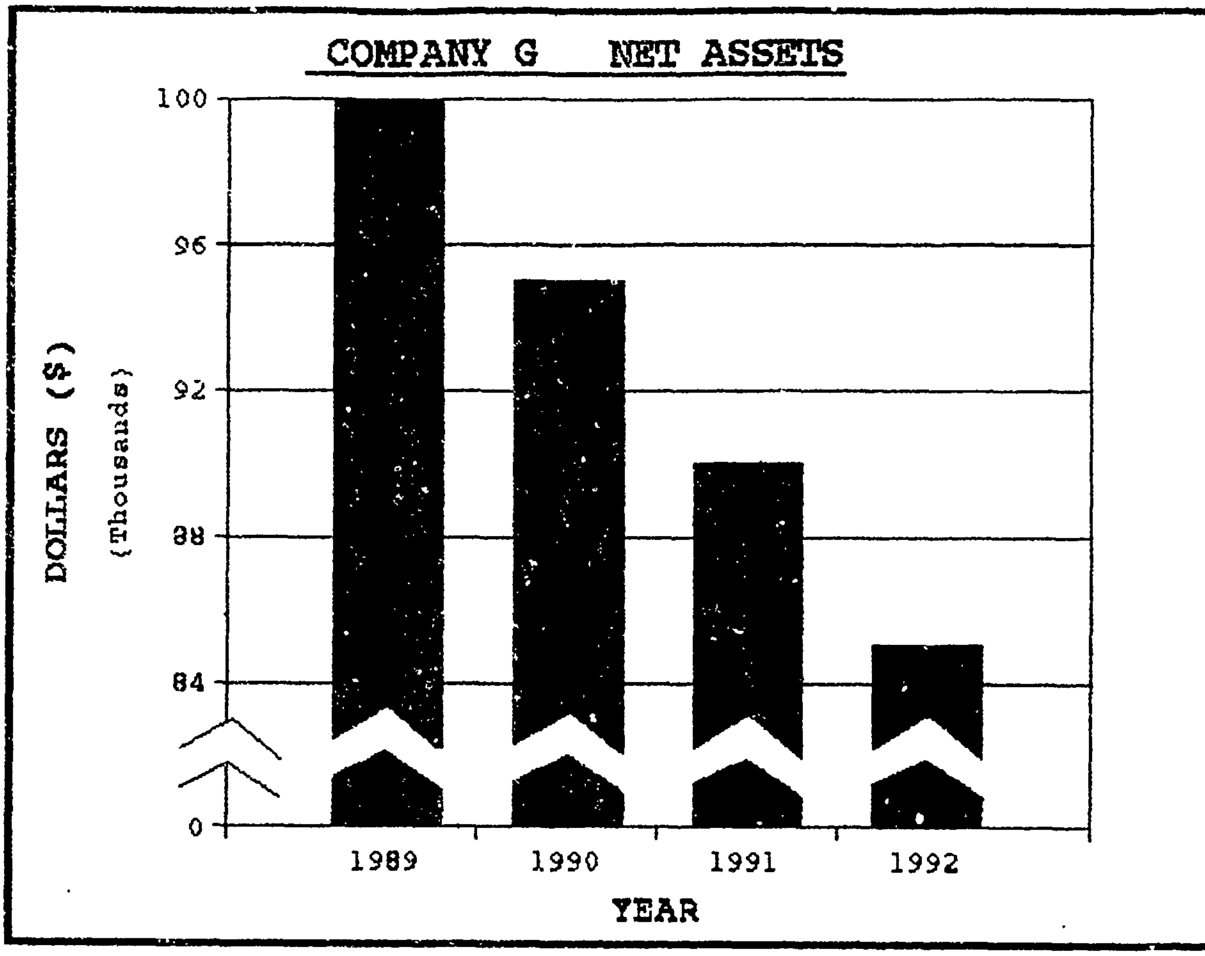

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
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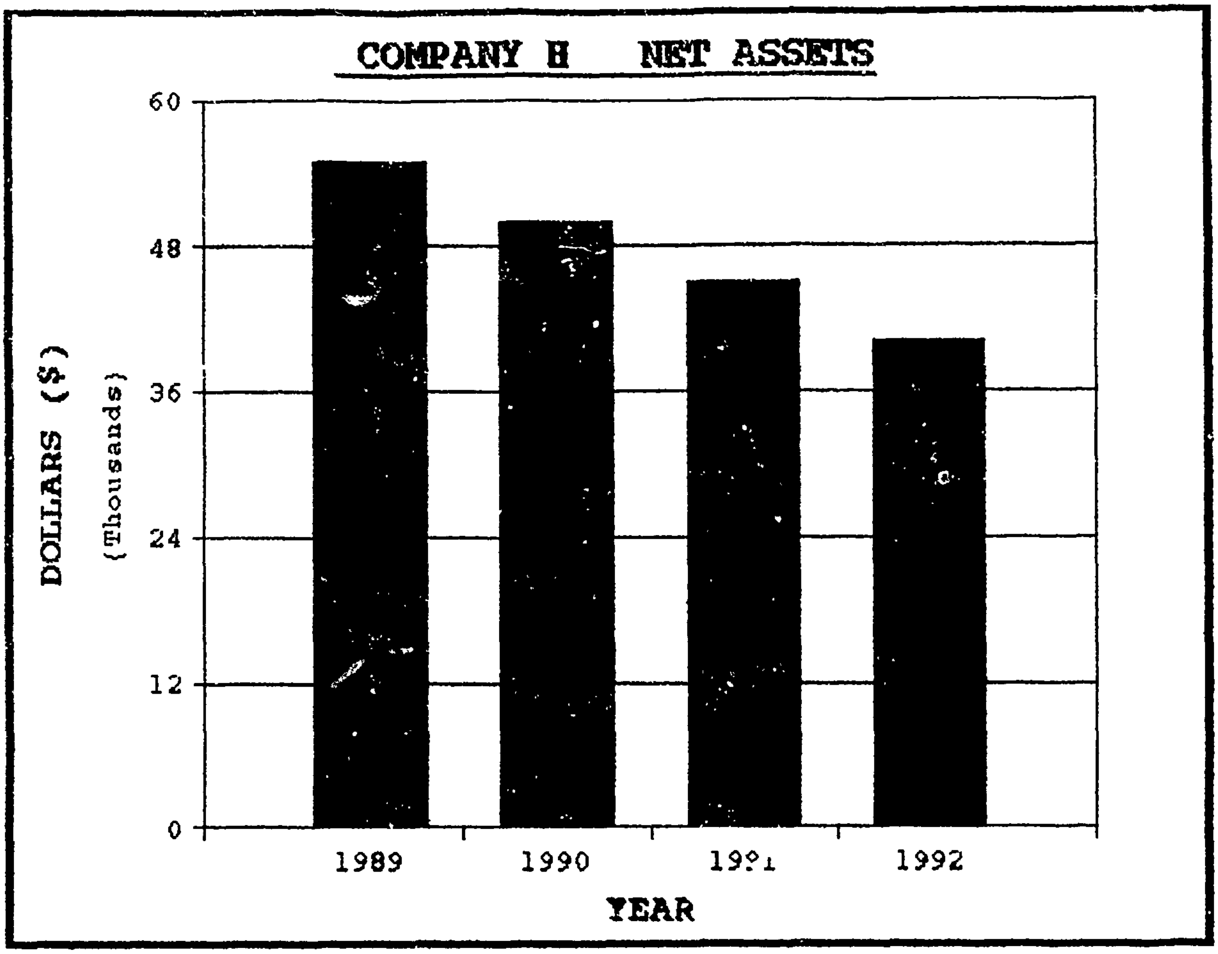

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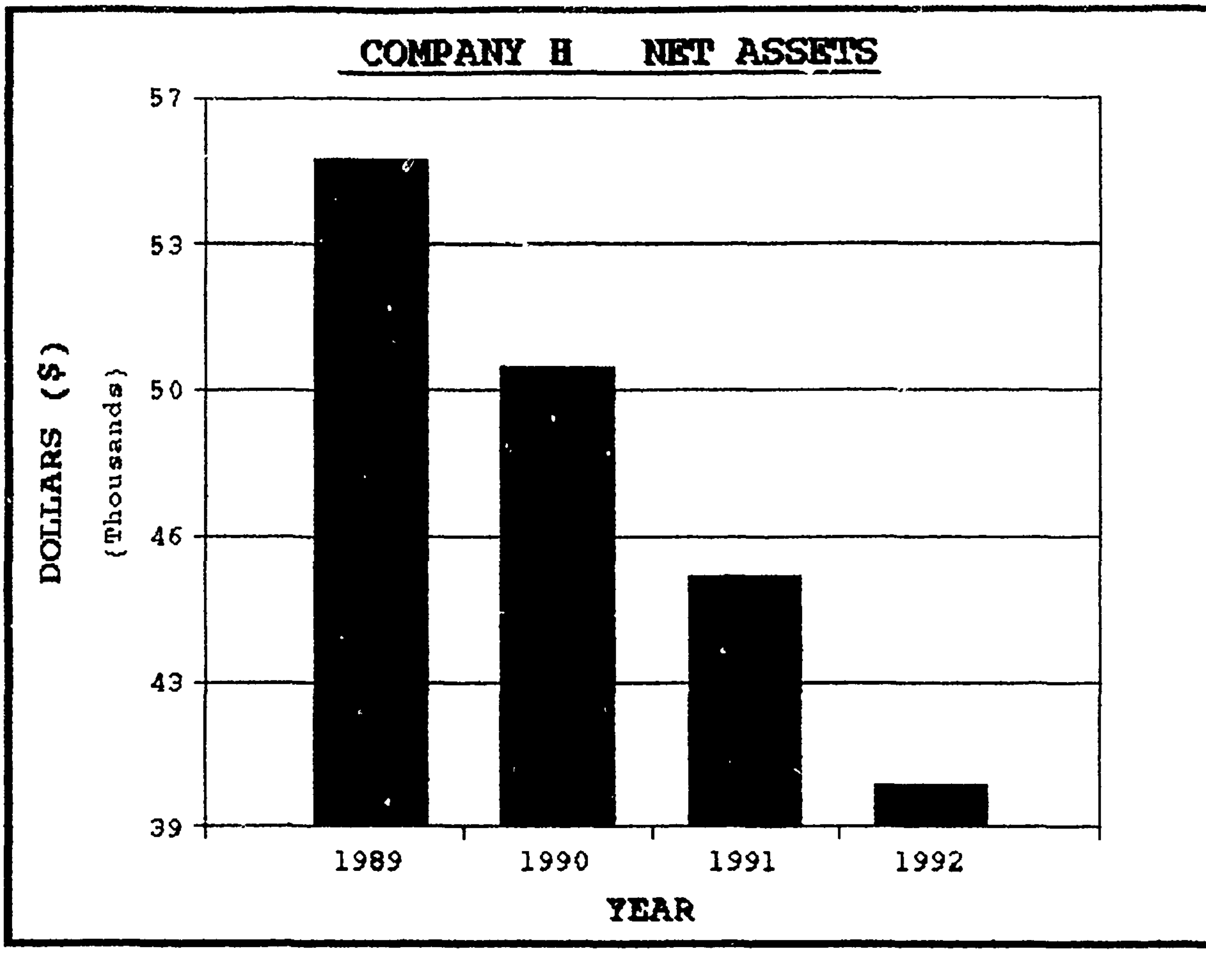
STOP!!

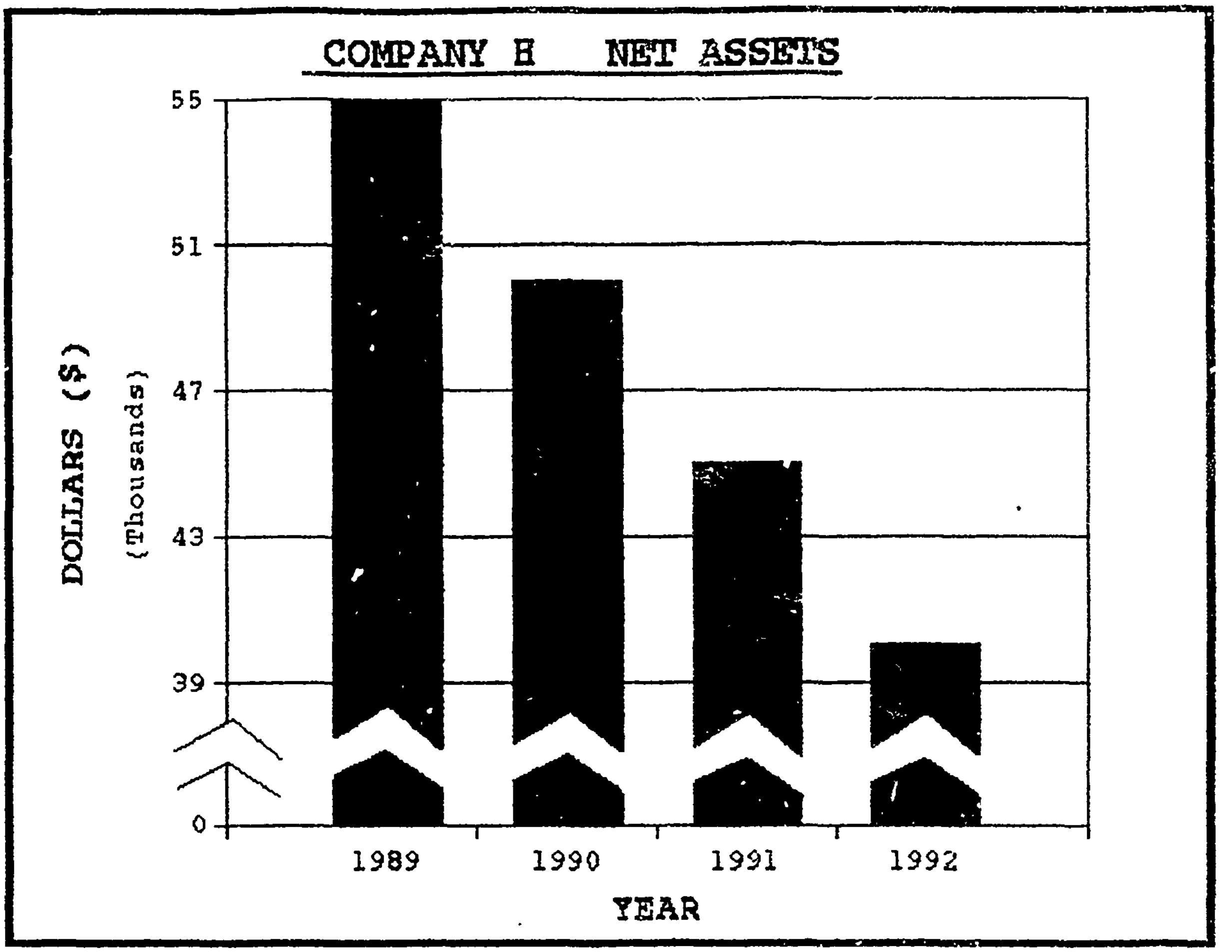
DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

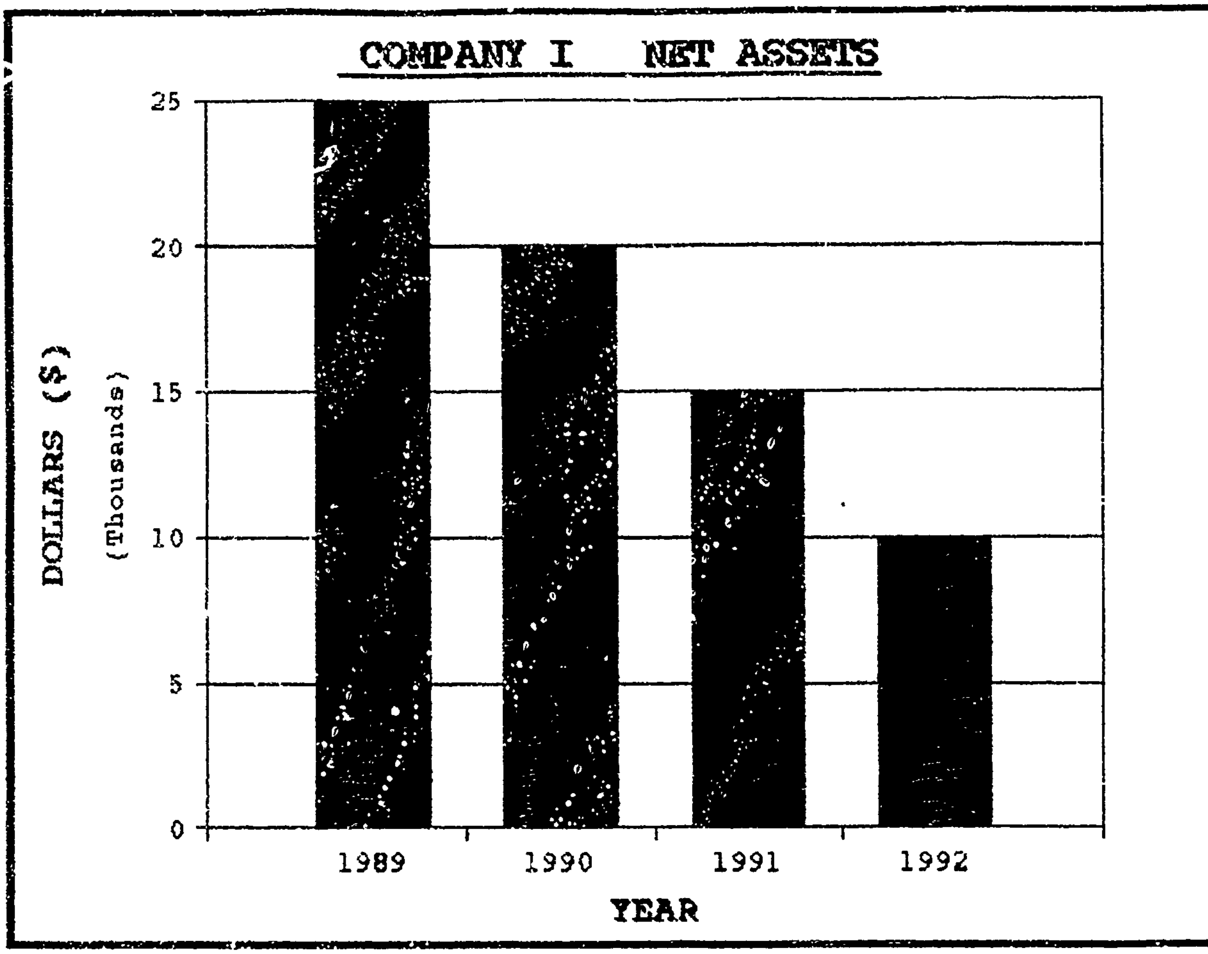
DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

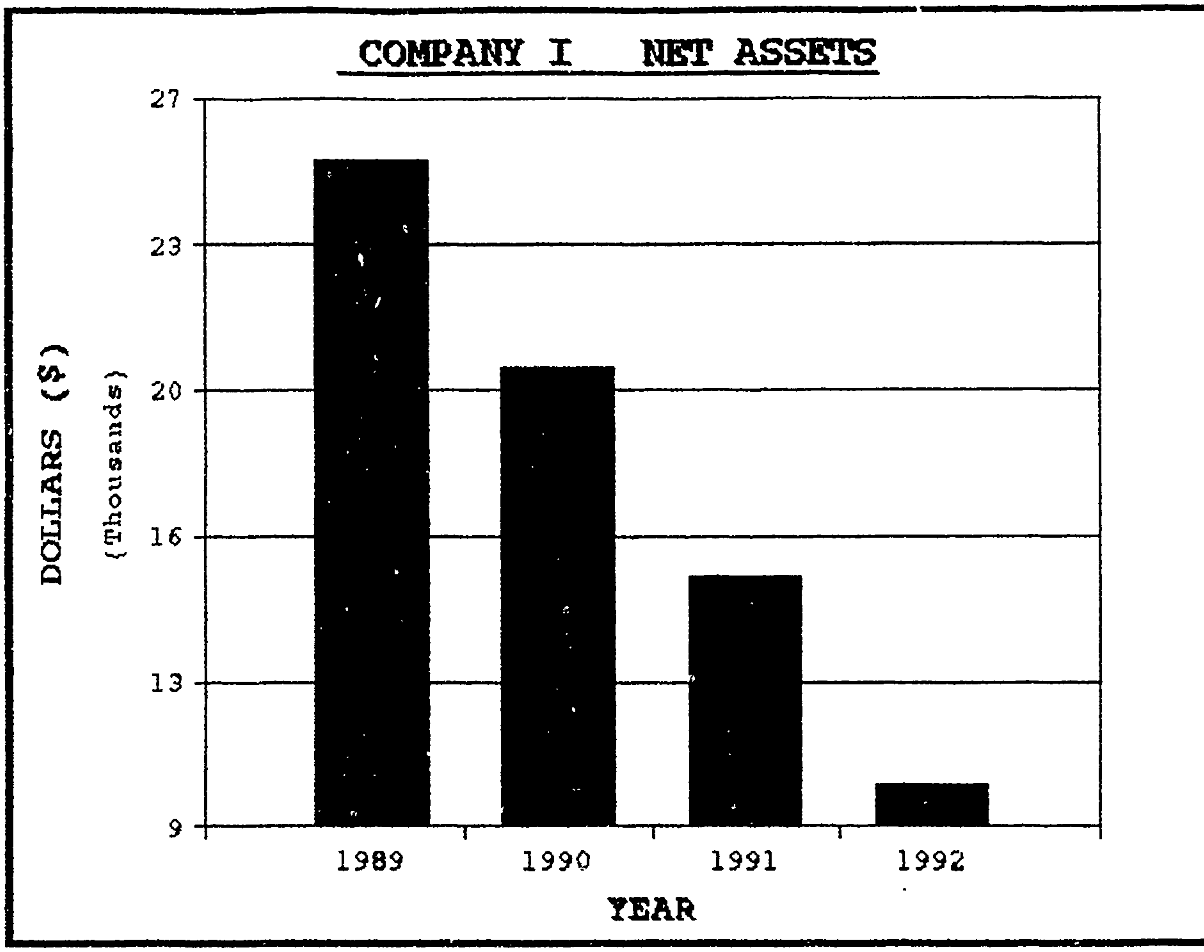
DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	15	20	25	30	35
Fluctuating	40	45	50	55	60
·creasing	65	70	75	80	85

STOP!!

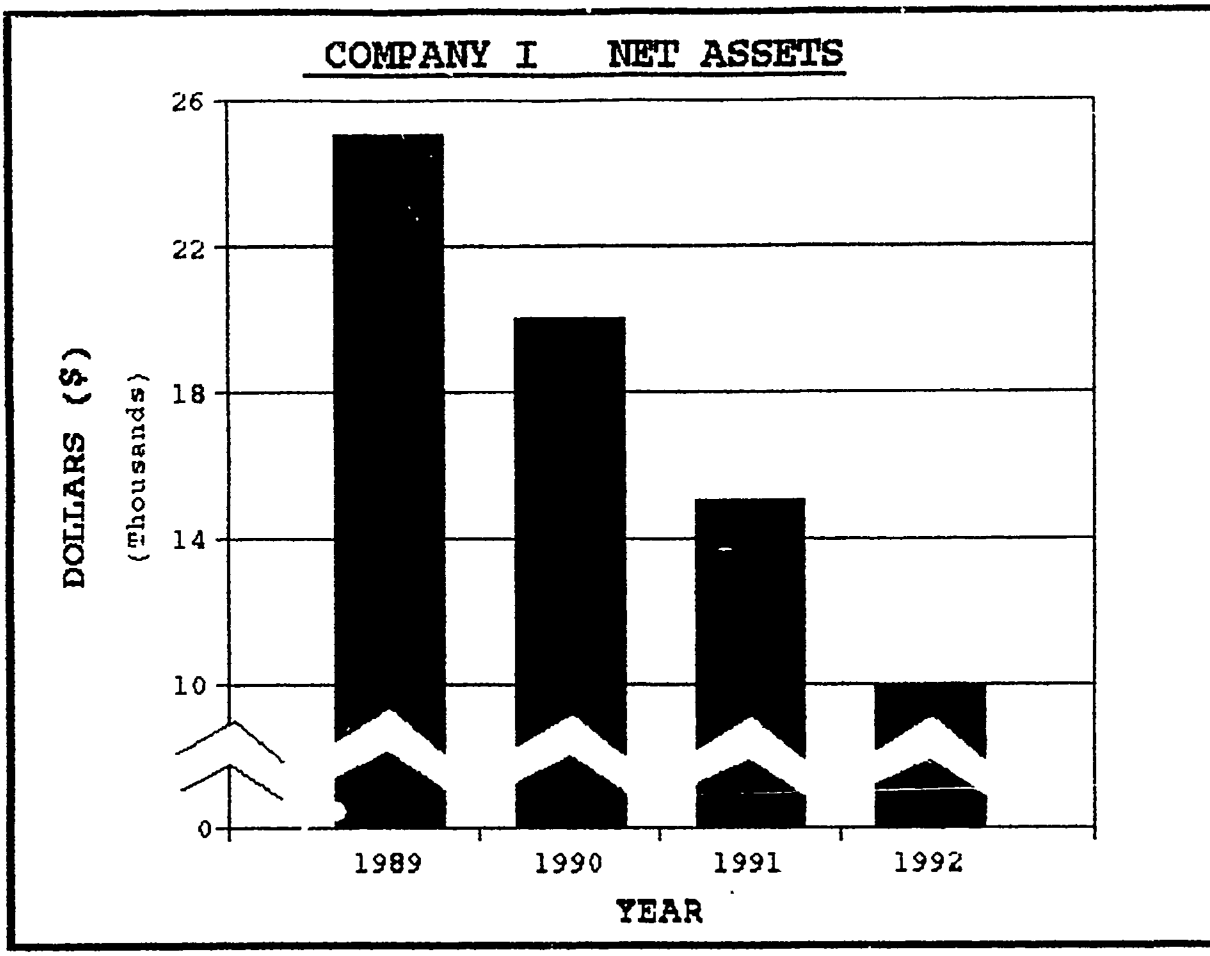
DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

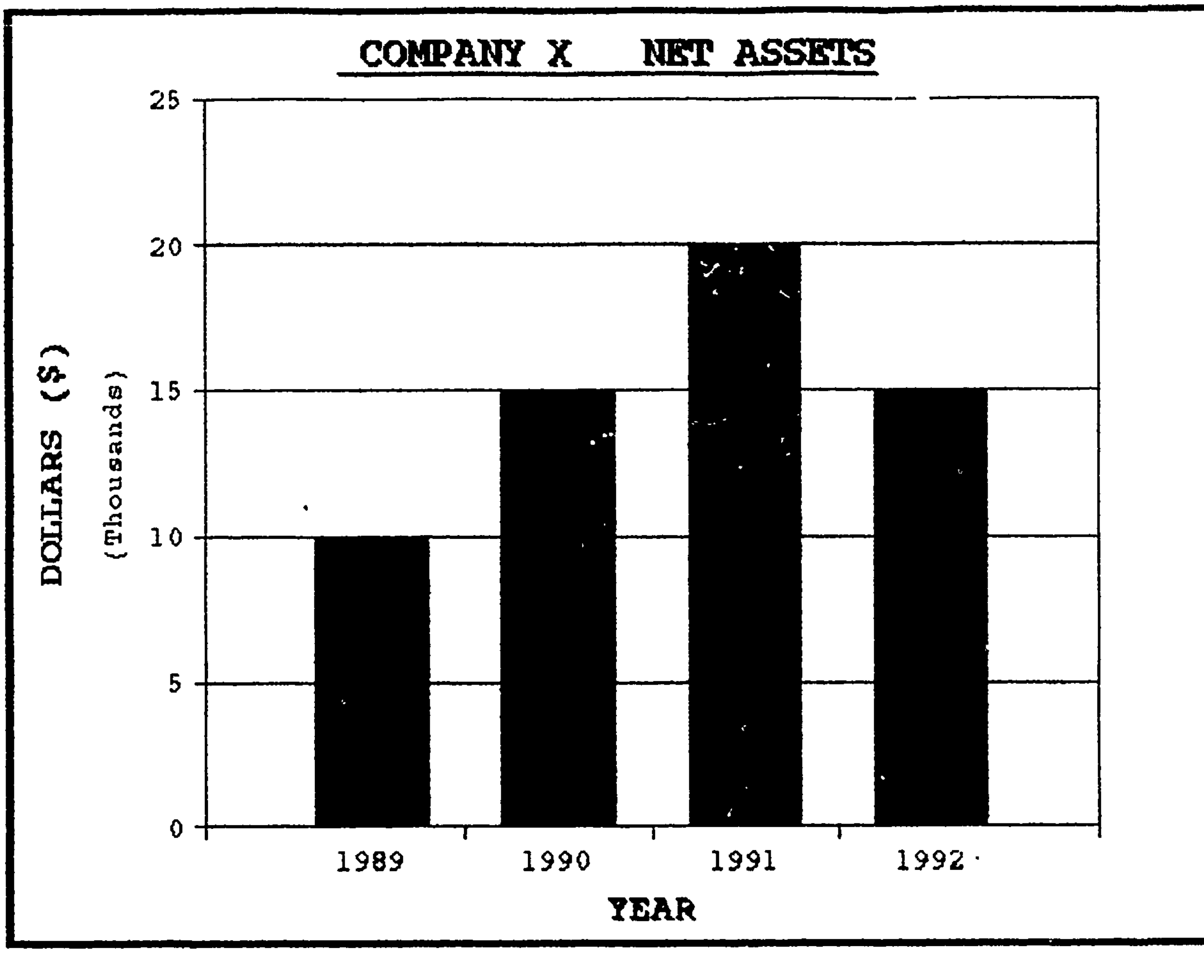
DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!



Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY A NET ASSETS

1989	$85,000
1990	$90,000
1991	$95,000
1992	$100,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY B NET ASSETS

1989	$40,000
1990	$45,000
1991	$50,000
1992	$55,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY C NET ASSETS

1989	$10,000
1990	$15,000
1991	$20,000
1992	$25,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY D NET ASSETS

1989	$90,000
1990	$95,000
1991	$90,000
1992	$95,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY E NET ASSETS

1989	$40,000
1990	$45,000
1991	$40,000
1992	$45,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY F NET ASSETS

1989	$10,000
1990	$15,000
1991	$10,000
1992	$15,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY G NET ASSETS

1989	$100,000
1990	$95,000
1991	$90,000
1992	$85,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY H NET ASSETS

1989	$55,000
1990	$50,000
1991	$45,000
1992	$40,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

COMPANY I NET ASSETS

1989	$25,000
1990	$20,000
1991	$15,000
1992	$10,000

Net Asset Trend	Amount of 4-year loan Percent of 1992 Net Assets				
Decreasing	**15**	**20**	**25**	**30**	**35**
Fluctuating	**40**	**45**	**50**	**55**	**60**
Increasing	**65**	**70**	**75**	**80**	**85**

STOP!!

DO NOT CONTINUE UNTIL YOU ARE TOLD TO DO SO!

Appendix D: Experiment Trend/Risk Analysis

This appendix contains the Trend/Risk Analysis portion of the experiment package. Each subject that took the experiment was asked to review the graphs one more time, and then to provide their impressions of the trends depicted. Additionally, they were asked to offer their opinion of the amount of risk involved in the loan for each of the graphs or tables in their package. For this part of the experiment, subjects were asked not to change any of their previous responses when they did the review.

Now that you have made a decision in each of the loan scenarios, we would like you to go back and give us your impression of the trend in net assets and your perception of the loan risk involved in each of the graphs. You may turn back to the page where the graph was first presented, but it is important that you not change any of your responses as you review the graphs.

Conclusions:

Graph #1. Company ____

The 4 year trend in net assets was:

Unimpressive: 1 2 3 4 5 6 7 8 9 : Impressive

The risk involved in this loan was:

Very low: 1 2 3 4 5 6 7 8 9 : Very high risk

Graph #2. Company ____

The 4 year trend in net assets was:

Unimpressive: 1 2 3 4 5 6 7 8 9 : Impressive

The risk involved in this loan was:

Very low: 1 2 3 4 5 6 7 8 9 : Very high risk

Graph #3. Company ____

The 4 year trend in net assets was:

Unimpressive: 1 2 3 4 5 6 7 8 9 : Impressive

The risk involved in this loan was:

Very low: 1 2 3 4 5 6 7 8 9 : Very high risk

CONTINUE ON TO THE NEXT PAGE

Now that you have made a decision in each of the loan scenarios, we would like you to go back and give us your impression of the trend in net assets and your perception of the loan risk involved in each of the tables. You may turn back to the page where the table was first presented, but it is important that you not change any of your responses as you review the tables.

Conclusions:

Table #1. Company ____

The 4 year trend in net assets was:

Unimpressive: 1 2 3 4 5 6 7 8 9 : Impressive

The risk involved in this loan was:

Very low: 1 2 3 4 5 6 7 8 9 : Very high risk

Table #2. Company ____

The 4 year trend in net assets was:

Unimpressive: 1 2 3 4 5 6 7 8 9 : Impressive

The risk involved in this loan was:

Very low: 1 2 3 4 5 6 7 8 9 : Very high risk

Table #3. Company ____

The 4 year trend in net assets was:

Unimpressive: 1 2 3 4 5 6 7 8 9 : Impressive

The risk involved in this loan was:

Very low: 1 2 3 4 5 6 7 8 9 : Very high risk

CONTINUE ON TO THE NEXT PAGE

Appendix E: Experiment Questionnaire

This appendix contains the 20 question demographic survey provided to each subject as the final part of each experiment package. Each subject was asked to select and circle the following: age, sex, rank, job experience levels, major Air Force commands they were assigned to prior to attending AFIT, formal or informal graph training if any, how frequently they constructed or looked at graphs as part of their job, if they constructed the graphs by hand or using a personal computer, and finally, what types of computer software did they use to prepare the graphs for their previous assignment. Additionally, three questions asked the subjects about the experiment itself: were the instructions easy to follow, what was the subjects' interest level in this experiment, and any comments they would like to add concerning the experiment or how it was conducted.

<u>Questionnaire</u>

PART I. This section asks for background information. Answers to these questions provide current demographic data. Please circle the response that best applies.

1. What is your age group?

    1. Under 21
    2. 21-24
    3. 25-28
    4. 29-32
    5. 33-36
    6. 37-40
    7. 41-44
    8. 45-48
    9. 49 and older

2. What is your sex?

    1. Female
    2. Male

3. What is your current educational level?

    1. High school diploma
    2. High School plus college but no degree
    3. Associate Degree
    4. Associate Degree plus
    5. Bachelors Degree
    6. Bachelors Degree plus
    7. Masters Degree
    8. Masters Degree plus
    9. Doctoral Degree

4. Which of the following areas do you consider to be the primary basis of your experience?

    1. Technical/Scientific
    2. Managerial/Supervisory
    3. Scientific
    4. Other ______________________.

5. How many years experience do you have in this area?

    1. less than 2
    2. 2 to 4
    3. 5 to 7
    4. 8 to 10
    5. 11 to 13
    6. 14 to 16
    7. 17 to 19
    8. 20 or more

6. In which of the following field do you have the most experience?

   1. Accounting
   2. Banking
   3. Contracting
   4. Engineering
   5. General Business
   6. Marketing
   7. Operations
   8. Support
   9. Other (Please specify) ____________________

7. How many years experience do you have in this field?

   1. less than 2
   2. 2 to 4
   3. 5 to 7
   4. 8 to 10
   5. 11 to 13
   6. 14 to 16
   7. 17 to 19
   8. 20 or more

8. Are you currently a Federal Government Employee?

   1. Yes
   2. No (<u>If no skip to question 13 in PART II</u>)

9. How many years of Federal Employment do you have?

   1. less than 2
   2. 2 to 4
   3. 5 to 7
   4. 8 to 10
   5. 11 to 13
   6. 14 to 16
   7. 17 to 19
   8. 20 or more

10. What is your current status?

    1. Civilian
    2. Active duty enlisted
    3. Active duty officer
    4. Reserve/Air National Guard enlisted
    5. Reserve/Air National Guard officer
    6. Other (please specify) ___________ ____________.

11. What is your current grade/rate?

1. GS-3 to GS-7
2. GS-8 to GS-12
3. GS/M-13 to GS/M-15
4. SES
5. E-1 to E-4
6. E-5 to E-6
7. E-7 to E-9
8. O-1 to O-3
9. O-4 to O-5
10. O-6 and above

12. If you are employed by the U.S. Air Force, to which Major Command are you assigned?

1. Air Combat Command (ACC)
2. Air Force Material Command (AFMC)
3. Air Mobility Command (AMC)
4. Air Training Command (ATC)
5. Air University (AU)
6. Pacific Air Forces (PACAF)
7. United States Air Forces Europe (USAFE)
8. Other (Please specify) ______________________.

PART II. The following questions are designed to find out what experience you have with graphs.

13. Have you eve   any training with graph construction or interpretation?

1. Yes, formal training on graph construction
2. Yes, formal training on graph interpretation
3. Yes, formal training on graph construction and interpretation
4. Yes, informal training on graph construction
5. Yes, informal training on graph interpretation
6. Yes, informal training on graph construction and interpretation
7. NO formal or informal training on graph construction or interpretation.

14. How often do you construct graphs for presentations?

1. Every day
2. Every other day
3. Once a week
4. Once a month
5. Once overy few months
6. Once a year
7. Never

15. How often do you use graphs in decision making?

1. Every day
2. Every other day
3. Once a week
4. Once a month
5. Once every few months
6. Once a year
7. Never
8. My position does not require decision making.

16. If you construct graphs do you:

1. Construct them manually (using pencil/pen and paper)
2. Construct them using a computer software package

17. If you construct graphs using software packages, list them in order from most used to least used.

1. ______________________________.

2. ______________________________.

3. ______________________________.

PART III. This part is designed to debrief you on the content of this experiment. We are interested in your comments about the experimental task and the design of the questionnaire.

18. Were the instructions clear and simple to follow?

1. Yes
2. No (Please indicate weaknesses or suggest improvements.)

19. What was your level of interest in the experimental task?

Very Low: 1 2 3 4 5 6 7 8 9 :Very High

20. Please make any comments or suggestions about this experiment that you think might be helpful. (Continue on the back if needed)

THANK YOU FOR YOUR COOPERATION IN THIS EXPERIMENT!

Appendix F: Description of Terms and Variables

This appendix contains a complete description of all terms and variables used in the spreadsheet prior to conducting the Analysis of Variance (ANOVA). Each column had shortened titles that represented a variable that was obtained from the subject responses when they completed the experiment package. Some variables represented aggregate values to aid in the analysis. Additionally, the terms used in the statistical software package *Statgraphics*, are also explained.

GLOSSARY OF TERMS AND VARIABLES

TERM/VARIABLE	DEFINITION
AGE	The demographic variable for subject's age. Response range values: 1 - 9 representing various age categories.
AREA	The demographic factor to represent the area the subject considered to be the primary basis of their experience. Response range values: 1 - 4 representing broad areas of experience.
AR-EX	The factor to represent the number of years of experience that the subject had in their primary area of work (defined by the variable AREA). Response range values: 1 - 8 representing from zero to 20 or more years of experience.
AUTO	The variable that represented whether or not the subject constructed graphs manually (with pen/pencil and paper) or automatically (i.e. with a computer software package). The responses values 1 and 2 represented manually and automatically respectively.
CLR	The variable representing whether or not the subject felt the instructions were clear. The response 1 or 2 represented yes the instructions were clear and no the instructions were not clear respectively.
COMPANY	The variable found in the smaller files representing the company name (A-I) used to eliminate the trend factor effect and to eliminate the company size factor effect.
DISP_TYPE	The variable found in the smaller files representing the display type (Z, NZ, SB, T) used to make the output from *Statgraphics* more understandable.
FEMP	A variable that represented whether or not the subject was an employee of the federal government. Response range values: 1 - 2 representing yes and no respectively.
FE-XP	The variable representing the number of years the subject had in Federal Government Service. Response range values 1 - 8 represented from zero to 20 or more years of service.
FLD	The demographic variable to represent the career field the subject considered to be the primary basis of their experience. Response range values: 1 - 4 representing specific fields of experience.

FL-EX The variable to represent the number of years of experience that the subject had in their primary career field (defined by the variable FLD). Response range values: 1 - 8 representing from zero to 20 or more years of experience.

ID# Unique sequential number assigned to each experimental package for tracking purposes. Range of values: 1 - 180.

ED The demographic variable to represent the subject's educational level. Response range values: 1 - 9 representing various educational levels.

F1-R1 Factor one, response one. This represents the factor for the type of presentation. The levels for this factor are T, Z, SB, and NZ. Where T = Table, Z = Graph starting at zero, SB = Graph with scale break, NZ = Graph starting from a non-zero point on the dependent axis.

F2-R1 Factor two, response one. This represents the factor for the type of trend. The levels for this factor are I, F, and D. I = Increasing trend, F = Fluctuating trend, D = Decreasing trend.

F3-R1 Factor three, response one. This represents the factor for the company name. Range of responses: A, D, or G, each representing one of the three companies.

F3-R2 Factor three, response two. This represents the factor for the company name. Range of responses: B, E, or H, each representing one of the three companies.

F3-R3 Factor three, response three. This represents the factor for the company name. Range of responses: C, F, or I, each representing one of the three companies.

GRADE The variable that represented the subject's pay grade in their Federal Government employment. Response range values of 1 - 10 represented all civilian, enlisted, commissioned officer pay grades.

GRCON The variable that represented the frequency that the subject constructed graphs for presentations. The response range 1 - 7 represented various levels from daily construction of graphs to never constructing graphs.

GRTNG The variable that represented the level of training that subjects had in graph construction and graph interpretation. The range of responses: 1 - 7 represented levels from formal training to no training at all.

GRUSE — The variable that represented the frequency with which the subjects used graphs in the decision making process. The range of responses: 1 - 8 represented levels from daily graph usage to no graph usage.

INT — The response the subject's provided concerning their level of interest in the experiment. The responses ranged on a scale from 1 - 9, with 1 representing very low interest and 9 very high interest.

LARGE` — A file containing all of the reaponse data for subjects who viewed companies with relatively large net assets. It included companies A, D, and G.

MAJCOM — The variable to represent the command to which the subject's were currently assigned. If assigned to the Air Force Institute of Technology as a graduate student, subjects were asked to provide data on their previous assignment.

MEDIUM — A file containing all of the response data for subjects who viewed companies with net assets in the medium range. It included companies B, E, and H.

NDECR — A file containing all of the data for decreasing trend display modes (Companies G, H, and I).

NFLUCT — A file containing all of the data for fluctuating trend display modes (Companies D, E, andF).

NINCR — A file containing all of the data for increasing trend display modes (Companies A, B, and C).

NORM_RESP — The normalized value for the responses fiven by each subject for their decision based on the graph or table viewed. See NRADG, and NRBEH.

NRADG — The normalized value for the response given by each subject for their decision based on the graph or table representing the net assets for company A, D, or G. The normalized value was reached by subtracting 50 from the raw response for company A and by subtracting 25 from the raw response for company D. Range of values: 15 - 35.

NRBEH — The normalized value for the response given by each subject for their decision based on the graph or table representing the net assets for company B, E, or H. The normalized value was reached by subtracting 50 from the raw response for company B and by subtracting 25 from the raw response for company E. Range of values: 15 - 35.

NRCFI	The normalized value for the response given by each subject for their decision based on the graph or table representing the net assets for company C, F, or I. The normalized value was reached by subtracting 50 from the raw response for company C and by subtracting 25 from the raw response for company F. Range of values: 15 - 35.
RADG	The actual response (raw) given by each subject for their decision based on the graph or table representing company A, D, or G. Range of values: A = 65 - 85, D = 40 - 60, and G = 15 - 35.
RBEH	The actual response (raw) given by each subject for their decision based on the graph or table representing company B, E, or H. Range of values: B = 65 - 85, E = 40 - 60, and H = 15 - 35.
RCFI	The actual response (raw) given by each subject for their decision based on the graph or table representing company C, F, or I. Range of values: C = 65 - 85, F = 40 - 60, and I = 15 - 35.
RISK1	The subjects risk assessment for the graph or table stored first in the spread sheet. Represents the risk impression for graphs or tables A, D, or G.
RISK2	The subjects risk assessment for the graph or table stored second in the spread sheet. Represents the risk impression for graphs or tables B, E, or H.
RISK3	The subjects risk assessment for the graph or table stored third in the spread sheet. Represents the risk impression for graphs or tables C, F, or I.
SEX	The demographic response for subject's gender. Range of responses: 1 - 2 represented female and male respectively.
SMALL	A file containing all of the response data for subjects who viewed companies with realtively small net assets. It included companies C, F, and I.
SOFT1	The response variable representing the software package used most frequently by the subject to construct graphs. This response was a fill in the blank type question.
SOFT2	The response variable representing the software package used second most frequently by the subject to construct graphs. This response was a fill in the blank type question.

SOFT3	The response variable representing the software package used third most frequently by the subject to construct graphs. This response was a fill in the blank type question.
STAT	The response the subjects gave for their current status with the Federal Government. Response values ranged from 1 - 6 representing statuses from civilian to active duty to reserve and Air National Guard.
TNORM	Total of the subjects normalized responses to all 3 graphs or tables. It represents the sum of the NRADG, NRBEH, and NRCFI responses.
TREN_TYPE	The factor representing the type of data trend observed by the subjects. It represented increasing, decreasing, and fluctuating trends in the smaller files used for data analysis.
TREN1	The subjects trend assessment for the graph or table stored first in the spread sheet. Represents the trend impression for graphs or tables A, D, or G.
TREN2	The subjects trend assessment for the graph or table stored second in the spread sheet. Represents the trend impression for graphs or tables B, E, or H.
TREN3	The subjects trend assessment for the graph or table stored third in the spread sheet. Represents the trend impression for graphs or tables C, F, or I.
TRES	Total of the subjects (raw) responses to all 3 graphs or tables. It represents the sum of the RADG, RBEH, and RCFI responses.
TRISK	Total of the subjects responses to all 3 risk assessments. It represents the sum of the RISK1, RISK2, and RISK3 responses.
TTREN	Total of the subjects responses to all 3 trend assessments. It represents the sum of the TREN1, TREN2, and TERN3 responses.

Appendix G: Experimental Data

This appendix contains the spreadsheet with the responses of all the variables obtained from the 180 subjects tested in this experiment. The Microsoft *Excel* spreadsheet file was saved as a Lotus 1-2-3 spreadsheet file with a .WK1 DOS file extension so that it could be imported into *Statgraphics* for analysis. The entire spreadsheet consists of 16 columns sectioned by 540 rows. Each column represents a short name version of a variable that was obtained or generated from the subjects when they completed the experiment package. Each row respresents the responses gathered from each individual subject. Each subject is represented three times, one for each of the three data sets.

ID#	RADG	NRADG	F1-R1	F2-R1	F3-R1	TREN1	RISK1	AGE	SEX	ED	AREA	FLD	GRTNG	CLR	INT
12	85	35	Z	I	A	7	2	5	2	7	3	3	6	1	5
17	75	25	Z	I	A	8	2	3	1	5	1	1	6	1	7
25	75	25	Z	I	A	8	3	7	2	7	4	1	3	1	5
48	75	25	Z	I	A	5	4	3	2	5	2	8	7	1	5
63	65	15	Z	I	A	4	4	4	2	6	2	4	3	1	7
99	85	35	Z	I	A	7	2	3	1	6	1	3	3	1	7
100	85	35	Z	I	A	7	4	5	2	5	2	9	7	1	6
106	65	15	Z	I	A	3	6	3	2	6	4	5	3	1	5
119	75	25	Z	I	A	7	3	3	2	5	2	1	6	1	7
120	80	30	Z	I	A	2	6	6	2	5	2	8	7	1	5
121	85	25	Z	I	A	7	3	4		6	2	7	7	1	6
124	80	30	Z	I	A	7	3	5	2	8	2	8	3	1	5
128	70	20	Z	I	A	6	5	3	2	5	2	8	6	1	6
129	70	20	[illegible]	I	A	6	4	4	2	6	2	8	3	1	3
138	70	20	Z	I	A	5	3	4	2	6	2	8	5	1	5
3A	50	25	Z	F	D	6	3	3	1	7	3	4	3	1	7
20	60	35	Z	F	D	5	1	6	1	8	2	5	3	1	6
27	60	35	Z	F	D	2	2	7	1	7	1	1	5	1	7
43	50	25	Z	F	D	3	3	4	2	5	2	8	5	1	4
51	60	35	Z	F	D	5	3	3	2	6	1	9	3	1	5
55A	60	35	Z	F	D	1	1	5	1	8	2	5	6	1	7
98	60	35	Z	F	D	5	2	7	1	6	3	9	3	1	6
132	60	35	Z	F	D	8	1	3	1	5	2	8	6	1	6
133	55	30	Z	F	D	7	3	3	2	5	2	8	3	1	5
136	60	35	Z	F	D	8	2	6	1	6	2	7	7	1	6
142	50	25	Z	F	D	3	3	4	2	6	2	9	3	2	6
143	50	25	Z	F	D	7	3	4	2	5	2	4	6	1	6
144	55	30	Z	F	D	5	3	3	2	5	2	8	3	1	5
146	60	35	Z	F	D	7	2	3	2	6	1	8	7	1	7
179	55	30	Z	F	D	8	2	3	2	6	2	8	6	1	5
8	25	25	Z	D	G	6	5	9	1	2	3	3	5	1	7
22	35	35	Z	D	G	2	2	4	1	5	3	1	3	1	5
31	35	35	Z	D	G	1	1	6	1	5	1	1	6	1	9
77	30	30	Z	D	G	3	4	5	2	5	2	8	7	1	5
85	30	30	Z	D	G	6	3	3	2	5	2	9	7	1	4
91	25	25	Z	D	G	5	3	3	2	5	2	8	6	1	5
93	25	25	Z	D	G	5	3	5	2	6	1	7	5	1	4
140	35	35	Z	D	G	6	6	4	2	6	2	7	3	1	5
167	30	30	Z	D	G	2	4	5	2	8	2	7	6	1	7
172	30	30	Z	D	G	4	4	5	2	6	1	7	4	1	6
173	35	35	Z	D	G	5	4	3	2	6	2	3	4	1	7
174	35	35	Z	D	G	5	3	5	2	6	1	7	7	1	3
175	20	20	Z	D	G	7	4	6	2	6	2	3	3	1	5
176	25	25	Z	D	G	7	7	3	1	6	2	8	3	1	8
177	20	20	Z	D	G	7	5	3	2	6	3	9	1	1	3
13	80	30	NZ	I	A	9	3	7	2	6	3	1	6	2	1
16	70	20	NZ	I	A	8	5	9	2	5	1	4	1	1	5
26	75	25	NZ	I	A	6	4	6	1	6	1	4	3	1	5

37	85	35	NZ	I	A	5	2	4	2	6	2	8	3	1	6
44	75	25	NZ	I	A	5	5	8	2	6	3	2	3	1	5
46	70	20	NZ	I	A	3	7	6	2	8	2	8	7	1	6
47	85	35	NZ	I	A	8	1	3	2	5	2	8	3	1	7
117	65	15	NZ	I	A	5	5	7	2	6	1	3	1	1	7
118	80	30	NZ	I	A	7	4	4	2	5	2	3	6	1	4
122	80	30	NZ	I	A	5	3	4	2	5	2	6	3	1	5
123	70	20	NZ	I	A	7	3	7	1	6	2	8	3	1	5
125	85	35	NZ	I	A	9	1	4	1	5	2	8	7	1	7
126	80	30	NZ	I	A	6	1	4	2	5	2	8	7	1	5
134	75	25	NZ	I	A	7	3	3	1	5	2	8	7	1	5
141	75	25	NZ	I	A	6	4	5	2	5	2	7	6	1	7
1	45	20	NZ	F	D	6	6	8	2	8	4	1	3	1	4
21	40	15	NZ	F	D	9	9	8	2	4	2	1	3	1	5
28	45	20	NZ	F	D	6	7	9	2	6	1	4	6	1	7
39	60	35	NZ	F	D	2	2	3	2	5	2	1	6	1	6
41	50	25	NZ	F	D	7	3	5	2	7	2	7	7	1	6
42	45	20	NZ	F	D	5	4	4	2	6	2	9	4	1	7
50	55	30	NZ	F	D	7	3	3	2	6	2	1	1	1	7
71	40	15	NZ	F	D	7	6	3	2	6	2	8	7	1	5
88	55	30	NZ	F	D	1	2	3	2	5	2	5	4	1	7
97	55	30	NZ	F	D	7	3	3	1	6	2	8	1	1	5
105	45	20	NZ	F	D	3	6	5	2	6	1	4	6	1	5
152	55	30	NZ	F	D	3	3	3	2	6	2	9	3	1	7
153	45	20	NZ	F	D	6	3	4	2	6	1	7	7	1	6
154	60	35	NZ	F	D	9	1	6	2	8	2	8	3	1	6
180	45	20	NZ	F	D	5	4	6	1	6	2	9	3	1	5
7	30	30	NZ	D	G	6	5	5	2	5	2	5	3	1	6
11	20	20	NZ	D	G	8	8	8	2	6	1	1	3	1	6
66	35	35	NZ	D	G	4	5	3	2	6	3	7	7	1	5
69	15	15	NZ	D	G	3	7	3	2	6	1	8	7	1	5
73	25	25	NZ	D	G	4	4	3	2	5	1	4	6	1	6
74	30	30	NZ	D	G	5	5	3	2	6	1	4	6	1	4
78	35	35	NZ	D	G	5	3	3	1	6	2	8	6	1	3
80	25	25	NZ	D	G	4	5	3	4	6	2	8	4	1	5
87	35	35	NZ	D	G	5	5	3	2	6	2	9	7	1	7
92	20	20	NZ	D	G	2	8	4	2	5	2	3	3	1	6
101	20	20	NZ	D	G	9	2	6	1	5	1	7	6	1	3
160	30	30	NZ	D	G	5	3	4	2	6	2	7	7	1	3
162	25	25	NZ	D	G	9	9	6	2	6	2	8	7	1	7
163	15	15	NZ	D	G	3	1	5	2	6	1	4	1	1	7
171	20	20	NZ	D	G	2	6	4	2	8	1	4	3	1	8
2	75	25	SB	I	A	7	2	6	2	9	2	3	7	1	5
14	80	30	SB	I	A	3	8	4	2	7	4	1	3	1	2
19	80	30	SB	I	A	7	4	7	2	6	1	8	3	2	2
54A	65	15	SB	I	A	3	6	5	2	5	2	4	7	1	5
56A	75	25	SB	I	A	9	1	4	2	6	2	8	7	1	7
57A	85	35	SB	I	A	6	4	4	2	6	1	4	7	1	5
58A	75	25	SB	I	A	7	4	3	2	5	2	8	4	1	4

103A	75	25	SB	I	A	6	4	6	2	8	4	3	3	1	9
109A	65	15	SB	I	A	1	9	5	2	5	4	8	3	1	5
110A	85	35	SB	I	A	9	2	2	1	6	3	5	3	1	5
114A	80	30	SB	I	A	7	5	7	1	6	3	9	6	1	7
115A	75	25	SB	I	A	8	2	4	1	4	2	9	6	1	5
116A	85	35	SB	I	A	5	3	7	1	2	2	1	7	1	5
127A	70	20	SB	I	A	3	4	5	1	5	4	5	6	1	5
135A	80	30	SB	I	A	7	3	9	1	7	3	9	4	1	3
9	55	30	SB	F	D	4	2	9	1	5	4	8	7	1	3
23	50	25	SB	F	D	5	4	6	2	5	1	4	3	1	2
29	50	25	SB	F	D	1	3	7	2	7	1	3	7	1	5
33	60	35	SB	F	D	9	1	4	2	6	1	4	7	2	7
34	50	25	SB	F	D	3	2	4	2	7	2	1	6	1	8
67	50	25	SB	F	D	3	3	4	2	7	3	8	6	1	6
70	60	35	SB	F	D	6	4	4	1	6	2	4	7	1	7
84	60	35	SB	F	D	7	1	3	2	6	2	8	3	1	7
96	60	35	SB	F	D	9	1	4	2	5	2	5	7	1	7
107	55	30	SB	F	D	5	2	5	2	6	2	8	7	1	7
113	60	35	SB	F	D	5	2	4	2	5	2	8	7	1	5
150	55	30	SB	F	D	7	3	3	2	5	2	3	3	1	7
151	45	20	SB	F	D	4	4	3	2	7	1	7	4	1	5
155	60	35	SB	F	D	3	3	6	2	6	3	4	6	1	7
156	60	35	SB	F	D	6	3	4	2	6	2	8	6	1	2
10	25	25	SB	D	G	6	7	9	2	5	2	1	1	1	7
24	20	20	SB	D	G	6	6	7	2	7	2	1	6	1	1
32	35	35	SB	D	G	5	3	5	2	6	1	9	1	1	7
59	35	35	SB	D	G	5	5	3	2	5	2	3	2	1	6
60	15	15	SB	D	G	2	8	3	2	5	2	8	5	1	5
62	35	35	SB	D	G	4	5	5	2	6	2	8	3	1	6
76	30	30	SB	D	G	5	3	3		6	2	4	7	1	5
79	35	35	SB	D	G	7	2	3	2	6	2	7	1	1	7
81	35	35	SB	D	G	6	3	3	2	5	2	9	6	1	5
82	30	30	SB	D	G	5	6	5	2	6	2	9	6	1	4
94	15	15	SB	D	G	2	9	3	2	5	2	1	7	1	6
139	20	20	SB	D	G	5	5	4	2	5	2	2	3	1	6
159	20	20	SB	D	G	3	6	4	2	6	2	3	7	1	3
168	35	35	SB	D	G	2	5	5	2	5	1	7	3	1	4
170	30	30	SB	D	G	9	7	5	2	7	3	1	7	2	6
5	75	25	T	I	A	7	4	3	1	5	1	1	3	1	5
30	65	15	T	I	A	2	6	7	2	6	1	1	5	1	1
35	75	25	T	I	A	6	5	9	2	5	2	7	2	1	6
36	80	30	T	I	A	8	2	6	2	6	2	9	6	1	9
38	85	35	T	I	A	9	2	7	2	5	2	8	3	1	7
49	80	30	T	I	A	6	2	5	1	5	2	5	7	1	7
102	80	30	T	I	A	6	3	9	1	5	4	8	1	1	7
104	80	30	T	I	A	7	3	4	2	5	4	7	6	1	4
130	80	30	T	I	A	6	5	3	1	7	2	8	4	1	5
131	80	30	T	I	A	8	2	4	1	6	2	8	4	1	4
137	85	35	T	I	A	4	4	3	1	6	3	8	7	1	6

145	85	35	T	I	A	7	3	5	2	6	2	7	6	1	5
147	85	35	T	I	A	6	2	4	2	6	2	8	3	1	5
148	80	30	T	I	A	7	6	4	1	6	2	5	3	1	8
149	70	20	T	I	A	5	3	5	2	6	4	7	7	1	8
4A	50	25	T	F	D	7	4	4	1	5	4	1	7	1	7
18	55	30	T	F	D	3	2	3	1	5	1	1	3	1	2
40	45	20	T	F	D	4	6	4	2	6	2	7	6	1	7
65	40	15	T	F	D	4	3	4	2	5	1	4	6	1	5
72	60	35	T	F	D	5	5	3	2	5	2	9	6	1	3
75	50	25	T	F	D	5	4	3	2	6	1	4	6	1	3
86	60	35	T	F	D	9	1	4	2	6	2	9	7	1	6
90	55	30	T	F	D	8	3	3	1	5	2	8	6	1	6
95	50	25	T	F	D	6	5	4	2	6	2	4	3	1	5
108	60	35	T	F	D	1	2	3	1	5	3	3	6	1	7
112	60	35	T	F	D	2	8	2	1	5	2	3	3	1	5
157A	50	25	T	F	D	3	8	2	2	6	1	1	7	1	7
158	60	35	T	F	D	7	4	5	2	5	3	7	1	1	7
165	50	25	T	F	D	5	4	4	2	5	1	7	6	1	5
178	50	25	T	F	D	2	2	3	2	6	1	5	6	1	7
6	25	25	T	D	G	4	5	8	2	6	4	1	7	1	6
15	20	20	T	D	G	7	3	9	2	8	1	4	7	1	5
45	30	30	T	D	G	4	5	4	2	6	2	8		1	7
52	20	20	T	D	G	4	5	4	2	5	2			1	7
53	25	25	T	D	G	4	5	4	2	6	2			1	6
61	30	30	T	D	G	4	5	6	2	8	2	7	6	1	3
64	20	20	T	D	G	3	2	6	2	6	2	8	3	1	2
68	30	30	T	D	G	4	2	4	2	5	2	4	8	1	5
83	25	25	T	D	G	4	3	4	2	5	2	4	4	1	6
89	20	20	T	D	G	3	7	4	2	7	2	8	4	1	4
111	15	15	T	D	G	2	4	4	2	6	3	2	5	1	5
161	20	20	T	D	G	3	5	4	2	5	1	9	6	1	3
164	20	20	T	D	G	3	6	4	2	6	2	8	3	1	5
166	30	30	T	D	G	4	5	6	2	6	2	7	3	1	6
169	20	20	T	D	G	7	8	4	1	6	2	7	4	1	1
12	85	35	Z	I	B	8	2	5	2	7	3	3	6	1	5
17	70	20	Z	I	B	8	4	3	1	5	1	1	6	1	7
25	75	25	Z	I	B	5	4	7	2	7	4	1	3	1	5
48	80	30	Z	I	B	7	3	3	2	5	2	8	7	1	5
63	75	25	Z	I	B	7	3	4	2	6	2	4	3	1	7
99	85	35	Z	I	B	7	2	3	1	6	1	3	3	1	7
100	85	35	Z	I	B	6	5	5	2	5	2	9	7	1	6
106	75	25	Z	I	B	5	5	3	2	6	4	5	3	1	5
119	70	20	Z	I	B	5	5	3	2	5	2	1	6	1	7
120	85	35	Z	I	B	6	3	6	2	5	2	8	7	1	5
121	85	35	Z	I	B	7	3	4	2	6	2	7	7	1	6
124	80	30	Z	I	B	7	3	5	2	8	2	8	3	1	5
128	75	25	Z	I	B	7	4	3	2	5	2	8	6	1	6
129	65	15	Z	I	B	6	4	4	2	6	2	8	3	1	3
138	70	20	Z	I	B	6	5	4	2	6	2	8	5	1	5

3A	50	25	Z	F	E	6	3	3	1	7	3	4	3	1	7
20	60	35	Z	F	E	3	1	6	1	8	2	5	3	1	6
27	50	25	Z	F	E	3	3	7	1	7	1	1	5	1	7
43	50	25	Z	F	E	5	5	4	2	5	2	8	5	1	4
51	60	35	Z	F	E	5	4	3	2	6	1	9	3	1	5
55A	45	20	Z	F	E	5	5	5	1	8	2	5	6	1	7
98	55	30	Z	F	E	7	5	7	1	6	3	9	3	1	6
132	55	30	Z	F	E	6	3	3	1	5	2	8	6	1	6
133	55	30	Z	F	E	7	3	3	2	5	2	8	3	1	5
136	55	30	Z	F	E	6	4	6	1	6	2	7	7	1	6
142	50	25	Z	F	E	5	6	4	2	6	2	9	3	2	6
143	50	25	Z	F	E	5	4	4	2	5	2	4	6	1	6
144	60	35	Z	F	E	5	5	3	2	5	2	8	3	1	5
146	55	30	Z	F	E	5	5	3	2	6	1	8	7	1	7
179	50	25	Z	F	E	7	3	3	2	6	2	8	6	1	5
8	15	15	Z	D	H	9	9	9	1	2	3	3	5	1	7
22	30	30	Z	D	H	5	4	4	1	5	3	1	3	1	5
31	35	35	Z	D	H	1	1	6	1	5	1	1	6	1	9
77	20	20	Z	D	H	2	8	5	2	5	2	8	7	1	5
85	30	30	Z	D	H	6	4	3	2	5	2	9	7	1	4
91	20	20	Z	D	H	5	5	3	2	5	2	8	6	1	5
93	25	25	Z	D	H	4	5	5	2	6	1	7	5	1	4
140	30	30	Z	D	H	5	5	4	2	6	2	7	3	1	5
167	25	25	Z	D	H	5	[illegible]	5	2	8	2	7	6	1	7
172	20	20	Z	D	H	6	5	5	2	6	1	7	4	1	6
173	30	30	Z	D	H	6	6	3	2	6	2	3	4	1	7
174	30	30	Z	D	H	4	4	5	2	6	1	7	7	1	3
175	20	20	Z	D	H	6	4	6	2	6	2	3	3	1	5
176	25	25	Z	D	H	7	7	3	1	6	2	8	3	1	8
177	20	20	Z	D	H	7	7	3	2	6	3	9	1	1	3
13	80	30	NZ	I	B	9	3	7	2	6	3	1	6	2	1
16	70	20	NZ	I	B	8	5	9	2	5	1	4	1	1	5
26	80	30	NZ	I	B	7	3	6	1	6	1	4	3	1	5
37	75	25	NZ	I	B	7	5	4	2	6	2	8	3	1	6
44	80	30	NZ	I	B	6	5	8	2	6	3	2	3	1	5
46	75	25	NZ	I	B	5	5	6	2	8	2	8	7	1	6
47	85	35	NZ	I	B	8	1	3	2	5	2	8	3	1	7
117	75	25	NZ	I	B	7	5	7	2	6	1	3	1	1	7
118	80	30	NZ	I	B	7	4	4	2	5	2	3	6	1	4
122	80	30	NZ	I	B	5	3	4	2	5	2	6	3	1	5
123	75	25	NZ	I	B	6	5	7	1	6	2	8	3	1	5
125	85	35	NZ	I	B	8	2	4	1	5	2	8	7	1	7
126	80	30	NZ	I	B	6	3	4	2	5	2	8	7	1	5
134	75	25	NZ	I	B	8	2	3	1	5	2	8	7	1	5
141	75	25	NZ	I	B	6	4	5	2	5	2	7	6	1	7
1	45	20	NZ	F	E	6	6	8	2	8	4	1	3	1	4
21	40	15	NZ	F	E	9	9	8	2	4	2	1	3	1	5
28	40	15	NZ	F	E	7	8	9	2	6	1	4	6	1	7
39	55	30	NZ	F	E	5	4	3	2	5	2	1	6	1	6

41	40	15	NZ	F	E	5	5	5	2	7	2	7	7	1	6
42	50	25	NZ	F	E	6	4	4	2	6	2	9	4	1	7
50	55	30	NZ	F	E	6	5	3	2	6	2	1	1	1	7
71	40	15	NZ	F	E	7	6	3	2	6	2	8	7	1	5
88	50	25	NZ	F	E	3	4	3	2	5	2	5	4	1	7
97	55	30	NZ	F	E	6	4	3	1	6	2	8	1	1	5
105	45	20	NZ	F	E	3	7	5	2	6	1	4	6	1	5
152	45	20	NZ	F	E	5	4	3	2	6	2	9	3	1	7
153	40	15	NZ	F	E	3	6	4	2	6	1	7	7	1	6
154	40	15	NZ	F	E	6	7	6	2	8	2	8	3	1	6
180	45	20	NZ	F	E	4	4	6	1	6	2	9	3	1	5
7	15	15	NZ	D	H	4	3	5	2	5	2	5	3	1	6
11	15	15	NZ	D	H	8	8	8	2	6	1	1	3	1	6
66	20	20	NZ	D	H	4	3	3	2	6	3	7	7	1	5
69	15	15	NZ	D	H	2	7	3	2	6	1	8	7	1	5
73	20	20	NZ	D	H	3	5	3	2	5	1	4	6	1	6
74	20	20	NZ	D	H	3	7	3	2	6	1	4	6	1	4
78	30	30	NZ	D	H	4	6	3	1	6	2	8	6	1	3
80	25	25	NZ	D	H	3	5	3	4	6	2	8	4	1	5
87	30	30	NZ	D	H	4	6	3	2	6	2	9	7	1	7
92	25	25	NZ	D	H	2	8	4	2	5	2	3	3	1	6
101	20	20	NZ	D	H	9	2	6	1	5	1	7	6	1	3
160	25	25	NZ	D	H	5	3	4	2	6	2	7	7	1	3
162	20	20	NZ	D	H	7	7	6	2	6	2	8	7	1	7
163	15	15	NZ	D	H	5	8	5	2	6	1	4	1	1	7
171	15	15	NZ	D	H	4	5	4	2	8	1	4	3	1	8
2	75	25	SB	I	B	7	2	6	2	9	2	3	7	1	5
14	80	30	SB	I	B	6	6	4	2	7	4	1	3	1	2
19	75	25	SB	I	B	6	6	7	2	6	1	8	3	2	2
54A	75	25	SB	I	B	5	5	5	2	5	2	4	7	1	5
56A	80	30	SB	I	B	7	3	4	2	6	2	8	7	1	7
57A	85	35	SB	I	B	7	2	4	2	6	1	4	7	1	5
58A	80	30	SB	I	B	8	3	3	2	5	2	8	4	1	4
103A	75	25	SB	I	B	7	4	6	2	8	4	3	3	1	9
109A	65	15	SB	I	B	3	7	5	2	5	4	8	3	1	5
110A	85	35	SB	I	B	9	2	2	1	6	3	5	3	1	5
114A	85	35	SB	I	B	5	3	7	1	6	3	9	6	1	7
115A	70	20	SB	I	B	8	4	4	1	4	2	9	6	1	5
116A	75	25	SB	I	B	5	3	7	1	2	2	1	7	1	5
127A	70	20	SB	I	B	3	6	5	1	5	4	5	6	1	5
135A	80	30	SB	I	B	7	3	9	1	7	3	9	4	1	3
9	55	30	SB	F	E	3	1	9	1	5	4	8	7	1	3
23	50	25	SB	F	E	4	4	6	2	5	1	4	3	1	2
29	50	25	SB	F	E	1	3	7	2	7	1	3	7	1	5
33	60	35	SB	F	E	8	2	4	2	6	1	4	7	2	7
34	50	25	SB	F	E	3	3	4	2	7	2	1	6	1	8
67	40	15	SB	F	E	4	2	4	2	7	3	8	6	1	6
70	55	30	SB	F	E	5	5	4	1	6	2	4	7	1	7
84	60	35	SB	F	E	7	3	3	2	6	2	8	3	1	7

96	40	15	SB	F	E	7	3	4	2	5	2	5	7	1	7
107	50	25	SB	F	E	5	2	5	2	6	2	8	7	1	7
113	50	25	SB	F	E	5	4	4	2	5	2	8	7	1	5
150	50	25	SB	F	E	6	5	3	2	5	2	3	3	1	7
151	45	20	SB	F	E	3	4	3	2	7	1	7	4	1	5
155	55	30	SB	F	E	5	4	6	2	6	3	4	6	1	7
156	60	35	SB	F	E	4	4	4	2	6	2	8	6	1	2
10	20	20	SB	D	H	7	7	9	2	5	2	1	1	1	7
24	20	20	SB	D	H	5	5	7	2	7	2	1	6	1	1
32	15	15	SB	D	H	9	9	5	2	6	1	9	1	1	7
59	25	25	SB	D	H	4	6	3	2	5	2	3	2	1	6
60	15	15	SB	D	H	2	8	3	2	5	2	8	5	1	5
62	30	30	SB	D	H	3	6	5	2	6	2	8	3	1	6
76	20	20	SB	D	H	6	4	3		6	2	4	7	1	5
79	30	30	SB	D	H	4	6	3	2	6	2	7	1	1	7
81	20	20	SB	D	H	3	6	3	2	5	2	9	6	1	5
82	25	25	SB	D	H	4	7	5	2	6	2	9	6	1	4
94	15	15	SB	D	H	2	9	3	2	5	2	1	7	1	6
139	15	15	SB	D	H	8	2	4	2	5	2	2	3	1	6
159	15	15	SB	D	H	1	8	4	2	6	2	3	7	1	3
168	15	15	SB	D	H	1	7	5	2	5	1	7	3	1	4
170	20	20	SB	D	H	7	3	5	2	7	3	1	7	2	6
5	70	20	T	I	B	7	5	3	1	5	1	1	3	1	5
30	65	15	T	I	B	5	5	7	2	6	1	1	5	1	1
35	75	25	T	I	B	6	5	9	2	5	2	7	2	1	6
36	80	30	T	I	B	8	2	6	2	6	2	9	6	1	9
38	75	25	T	I	B	9	5	7	2	5	2	8	3	1	7
49	75	25	T	I	B	6	3	5	1	5	2	5	7	1	7
102	85	35	T	I	B	7	2	9	1	5	4	8	1	1	7
104	80	30	T	I	B	7	3	4	2	5	4	7	6	1	4
130	80	30	T	I	B	6	5	3	1	7	2	8	4	1	5
131	80	30	T	I	B	7	3	4	1	6	2	8	4	1	4
137	85	35	T	I	B	5	5	3	1	6	3	8	7	1	6
145	85	35	T	I	B	4	5	5	2	6	2	7	6	1	5
147	35	35	T	I	B	5	3	4	2	6	2	8	3	1	5
148	80	30	T	I	B	9	6	4	1	6	2	5	3	1	8
149	70	20	T	I	B	7	4	5	2	6	4	7	7	1	8
4A	50	25	T	F	E	7	4	4	1	5	4	1	7	1	7
18	50	25	T	F	E	4	3	3	1	5	1	1	3	1	2
40	50	25	T	F	E	5	5	4	2	6	2	7	6	1	7
65	40	15	T	F	E	4	3	4	2	5	1	4	6	1	5
72	55	30	T	F	E	4	6	3	2	5	2	9	6	1	3
75	50	25	T	F	E	4	5	3	2	6	1	4	6	1	3
86	50	25	T	F	E	5	5	4	2	6	2	9	7	1	6
90	50	25	T	F	E	6	5	3	1	5	2	8	6	1	6
95	50	25	T	F	E	5	5	4	2	6	2	4	3	1	5
108	60	35	T	F	E	3	5	3	1	5	3	3	6	1	7
112	55	30	T	F	E	5	5	2	1	5	2	3	3	1	5
157A	50	25	T	F	E	5	6	2	2	6	1	1	7	1	7

158	60	35	T	F	E	6	6	5	2	5	3	7	1	1	7
165	50	25	T	F	E	5	4	4	2	5	1	7	6	1	5
178	50	25	T	F	E	2	4	3	2	6	1	5	6	1	7
6	30	30	T	D	H	6	6	8	2	6	4	1	7	1	6
15	20	20	T	D	H	7	5	9	2	8	1	4	7	1	5
45	25	25	T	D	H	2	6	4	2	6	2	8	4	1	7
52	20	20	T	D	H	3	7	4	2	5	2	7	7	1	7
53	20	20	T	D	H	3	6	4	2	6	2	8	6	1	6
61	25	25	T	D	H	2	7	6	2	8	2	7	6	1	3
64	20	20	T	D	H	3	5	6	2	6	2	8	3	1	2
68	25	25	T	D	H	3	3	4	2	5	2	4	8	1	5
83	25	25	T	D	H	6	3	4	2	5	2	4	4	1	6
89	20	20	T	D	H	2	8	4	2	7	2	8	4	1	4
111	15	15	T	D	H	2	3	4	2	6	3	2	5	1	5
161	20	20	T	D	H	2	6	4	2	5	1	9	6	1	3
164	20	20	T	D	H	3	7	4	2	6	2	8	3	1	5
166	30	30	T	D	H	4	5	6	2	6	2	7	3	1	6
169	20	20	T	D	H	2	1	4	1	6	2	7	4	1	1
12	85	35	Z	I	C	7	4	5	2	7	3	3	6	1	5
17	70	20	Z	I	C	8	3	3	1	5	1	1	6	1	7
25	70	20	Z	I	C	7	7	7	2	7	4	1	3	1	5
48	75	25	Z	I	C	5	4	3	2	5	2	8	7	1	5
63	85	35	Z	I	C	9	1	4	2	6	2	4	3	1	7
99	85	35	Z	I	C	7	3	3	1	6	1	3	3	1	7
100	85	35	Z	I	C	6	5	5	2	5	2	9	7	1	6
106	80	30	Z	I	C	9	4	3	2	6	4	5	3	1	5
119	65	15	Z	I	C	6	4	3	2	5	2	1	6	1	7
120	85	35	Z	I	C	8	3	6	2	5	2	8	7	1	5
121	75	25	Z	I	C	8	5	4	2	6	2	7	7	1	6
124	80	30	Z	I	C	8	2	5	2	8	2	8	3	1	5
128	80	30	Z	I	C	9	3	3	2	5	2	8	6	1	6
129	65	15	Z	I	C	6	4	4	2	6	2	8	3	1	3
138	75	25	Z	I	C	7	7	4	2	6	2	8	5	1	5
3A	40	15	Z	F	F	8	7	3	1	7	3	4	3	1	7
20	45	20	Z	F	F	7	8	6	1	8	2	5	3	1	6
27	50	25	Z	F	F	3	3	7	1	7	1	1	5	1	7
43	50	25	Z	F	F	7	3	4	2	5	2	8	5	1	4
51	40	15	Z	F	F	6	5	3	2	6	1	9	3	1	5
55A	40	15	Z	F	F	7	9	5	1	8	2	5	6	1	7
98	50	25	Z	F	F	9	8	7	1	6	3	9	3	1	6
132	45	20	Z	F	F	5	6	3	1	5	2	8	6	1	6
133	55	30	Z	F	F	7	3	3	2	5	2	8	3	1	5
136	40	15	Z	F	F	4	6	6	1	6	2	7	7	1	6
142	45	20	Z	F	F	8	8	4	2	6	2	9	3	2	6
143	40	15	Z	F	F	3	6	4	2	5	2	4	6	1	6
144	45	20	Z	F	F	8	8	3	2	5	2	8	3	1	5
146	45	20	Z	F	F	3	7	3	2	6	1	8	7	1	7
179	45	20	Z	F	F	4	6	3	2	6	2	8	6	1	5
8	15	15	Z	D	I	9	9	9	1	2	3	3	5	1	7

22	15	15	Z	D	I	8	8	4	1	5	3	1	3	1	5
31	15	15	Z	D	I	9	9	6	1	5	1	1	6	1	9
77	15	15	Z	D	I	2	5	5	2	5	2	8	7	1	5
85	15	15	Z	D	I	2	8	3	2	5	2	9	7	1	4
91	15	15	Z	D	I	3	8	3	2	5	2	8	6	1	5
93	25	25	Z	D	I	3	7	5	2	6	1	7	5	1	4
140	25	25	Z	D	I	7	7	4	2	6	2	7	3	1	5
167	15	15	Z	D	I	8	8	5	2	8	2	7	6	1	7
172	15	15	Z	D	I	8	8	5	2	6	1	7	4	1	6
173	20	20	Z	D	I	8	7	3	2	6	2	3	4	1	7
174	20	20	Z	D	I	2	7	5	2	6	1	7	7	1	3
175	15	15	Z	D	I	8	1	6	2	6	2	3	3	1	5
176	25	25	Z	D	I	7	7	3	1	6	2	8	3	1	8
177	15	15	Z	D	I	9	9	3	2	6	3	9	1	1	3
13	70	20	NZ	I	C	9	5	7	2	6	3	1	6	2	1
16	70	20	NZ	I	C	8	5	9	2	5	1	4	1	1	5
26	85	35	NZ	I	C	8	2	6	1	6	1	4	3	1	5
37	85	35	NZ	I	C	9	5	4	2	6	2	8	3	1	6
44	85	35	NZ	I	C	7	5	8	2	6	3	2	3	1	5
46	80	30	NZ	I	C	7	3	6	2	8	2	8	7	1	6
47	85	35	NZ	I	C	8	1	3	2	5	2	8	3	1	7
117	65	15	NZ	I	C	9	1	7	2	6	1	3	1	1	7
118	85	35	NZ	I	C	9	3	4	2	5	2	3	6	1	4
122	80	30	NZ	I	C	8	2	4	2	5	2	6	3	1	5
123	80	30	NZ	I	C	6	5	7	1	6	2	8	3	1	5
125	85	35	NZ	I	C	8	2	4	1	5	2	8	7	1	7
126	85	35	NZ	I	C	7	2	4	2	5	2	8	7	1	5
134	80	30	NZ	I	C	8	2	3	1	5	2	8	7	1	5
141	75	25	NZ	I	C	7	4	5	2	5	2	7	6	1	7
1	45	20	NZ	F	F	6	6	8	2	8	4	1	3	1	4
21	40	15	NZ	F	F	9	9	8	2	4	2	1	3	1	5
28	45	20	NZ	F	F	8	9	9	2	6	1	4	6	1	7
39	50	25	NZ	F	F	6	8	3	2	5	2	1	6	1	6
41	40	15	NZ	F	F	3	9	5	2	7	2	7	7	1	6
42	45	20	NZ	F	F	4	6	4	2	6	2	9	4	1	7
50	50	25	NZ	F	F	5	6	3	2	6	2	1	1	1	7
71	40	15	NZ	F	F	7	6	3	2	6	2	8	7	1	5
88	40	15	NZ	F	F	5	8	3	2	5	2	5	4	1	7
97	55	30	NZ	F	F	5	6	3	1	6	2	8	1	1	5
105	45	20	NZ	F	F	3	8	5	2	6	1	4	6	1	5
152	40	15	NZ	F	F	8	7	3	2	6	2	9	3	1	7
153	40	15	NZ	F	F	2	8	4	2	6	1	7	7	1	6
154	40	15	NZ	F	F	2	8	6	2	8	2	8	3	1	6
180	40	15	NZ	F	F	7	3	6	1	6	2	9	3	1	5
7	15	15	NZ	D	I	8	9	5	2	5	2	5	3	1	6
11	15	15	NZ	D	I	9	9	8	2	6	1	1	3	1	6
66	25	25	NZ	D	I	4	7	3	2	6	3	7	7	1	5
69	15	15	NZ	D	I	1	9	3	2	6	1	8	7	1	5
73	15	15	NZ	D	I	2	8	3	2	5	1	4	6	1	6

74	15	15	NZ	D	I	1	9	3	2	6	1	4	6	1	4
78	15	15	NZ	D	I	3	7	3	1	6	2	8	6	1	3
80	20	20	NZ	D	I	3	6	3	4	6	2	8	4	1	5
87	20	20	NZ	D	I	3	7	3	2	6	2	9	7	1	7
92	35	35	NZ	D	I	2	8	4	2	5	2	3	3	1	6
101	15	15	NZ	D	I	9	2	6	1	5	1	7	6	1	3
160	30	30	NZ	D	I	3	5	4	2	6	2	7	7	1	3
162	15	15	NZ	D	I	8	8	6	2	6	2	8	7	1	7
163	25	25	NZ	D	I	5	5	5	2	6	1	4	1	1	7
171	15	15	NZ	D	I	3	3	4	2	8	1	4	3	1	8
2	75	25	SB	I	C	6	2	6	2	9	2	3	7	1	5
14	85	35	SB	I	C	9	2	4	2	7	4	1	3	1	2
19	60	15	SB	I	C	5	7	7	2	6	1	8	3	2	2
54A	80	30	SB	I	C	7	3	5	2	5	2	4	7	1	5
56A	85	35	SB	I	C	8	2	4	2	6	2	8	7	1	7
57A	85	35	SB	I	C	8	2	4	2	6	1	4	7	1	5
58A	80	30	SB	I	C	8	3	3	2	5	2	8	4	1	4
103A	80	30	SB	I	C	8	4	6	2	8	4	3	3	1	9
109A	65	15	SB	I	C	9	2	5	2	5	4	8	3	1	5
110A	85	35	SB	I	C	9	2	2	1	6	3	5	3	1	5
114A	85	35	SB	I	C	5	3	7	1	6	3	9	6	1	7
115A	70	20	SB	I	C	8	7	4	1	4	2	9	6	1	5
116A	80	30	SB	I	C	5	3	7	1	2	2	1	7	1	5
127A	70	20	SB	I	C	4	6	5	1	5	4	5	6	1	5
135A	80	30	SB	I	C	7	3	9	1	7	3	9	4	1	3
9	55	30	SB	F	F	3	1	9	1	5	4	8	7	1	3
23	45	20	SB	F	F	4	4	6	2	5	1	4	3	1	2
29	50	25	SB	F	F	8	8	7	2	7	1	3	7	1	5
33	45	20	SB	F	F	6	4	4	2	6	1	4	7	2	7
34	50	25	SB	F	F	3	4	4	2	7	2	1	6	1	8
67	40	15	SB	F	F	3	4	4	2	7	3	8	6	1	6
70	50	25	SB	F	F	4	7	4	1	6	2	4	7	1	7
84	55	30	SB	F	F	7	6	3	2	6	2	8	3	1	7
96	40	15	SB	F	F	3	7	4	2	5	2	5	7	1	7
107	55	30	SB	F	F	5	2	5	2	6	2	8	7	1	7
113	40	15	SB	F	F	5	8	4	2	5	2	8	7	1	5
150	50	25	SB	F	F	4	7	3	2	5	2	3	3	1	7
151	45	20	SB	F	F	2	3	3	2	7	1	7	4	1	5
155	50	25	SB	F	F	8	8	6	2	6	3	4	6	1	7
156	40	15	SB	F	F	1	9	4	2	6	2	8	6	1	2
10	20	20	SB	D	I	8	8	9	2	5	2	1	1	1	7
24	20	20	SB	D	I	3	3	7	2	7	2	1	6	1	1
32	15	15	SB	D	I	9	9	5	2	6	1	9	1	1	7
59	15	15	SB	D	I	2	8	3	2	5	2	3	2	1	6
60	15	15	SB	D	I	2	8	3	2	5	2	8	5	1	5
62	20	20	SB	D	I	2	9	5	2	6	2	8	3	1	6
76	15	15	SB	D	I	9	9	3		6	2	4	7	1	5
79	20	20	SB	D	I	2	8	3	2	6	2	7	1	1	7
81	15	15	SB	D	I	1	9	3	2	5	2	9	6	1	5

82	20	20	SB	D	I	3	8	5	2	6	2	9	6	1	4
94	15	15	SB	D	I	2	9	3	2	5	2	1	7	1	6
139	15	15	SB	D	I	8	2	4	2	5	2	2	3	1	6
159	15	15	SB	D	I	1	9	4	2	6	2	3	7	1	3
168	15	15	SB		I	1	9	5	2	5	1	7	3	1	4
170	35	35	SB		I	9	9	5	2	7	3	1	7	2	6
5	65	15	T	I	C	7	7	3	1	5	1	1	3	1	5
30	65	15	T	I	C	7	9	7	2	6	1	1	5	1	1
35	75	25	T	I	C	7	5	9	2	5	2	7	2	1	6
36	80	30	T	I	C	8	2	6	2	6	2	9	6	1	9
38	65	15	T	I	C	9	7	7	2	5	2	8	3	1	7
49	80	30	T	I	C	7	3	5	1	5	2	5	7	1	7
102	85	35	T	I	C	8	2	9	1	5	4	8	1	1	7
104	80	30	T	I	C	7	3	4	2	5	4	7	6	1	4
130	80	30	T	I	C	6	5	3	1	7	2	8	4	1	5
131	80	30	T	I	C	7	3	4	1	6	2	8	4	1	4
137	85	35	T	I	C	7	7	3	1	6	3	8	7	1	6
145	75	25	T	I	C	6	4	5	2	6	2	7	6	1	5
147	70	20	T	I	C	3	5	4	2	6	2	8	3	1	5
148	75	25	T	I	C	9	7	4	1	6	2	5	3	1	8
149	80	30	T	I	C	8	3	5	2	6	4	7	7	1	8
4A	50	25	T	F	F	7	4	4	1	5	4	1	7	1	7
18	50	25	T	F	F	4	3	3	1	5	1	1	3	1	2
40	50	25	T	F	F	6	4	4	2	6	2	7	6	1	7
65	45	20	T	F	F	5	3	4	2	5	1	4	6	1	5
72	40	15	T	F	F	7	2	3	2	5	2	9	6	1	3
75	50	25	T	F	F	4	5	3	2	6	1	4	6	1	3
86	50	25	T	F	F	1	9	4	2	6	2	9	7	1	6
90	50	25	T	F	F	3	6	3	1	5	2	8	6	1	6
95	50	25	T	F	F	5	6	4	2	6	2	4	3	1	5
108	55	30	T	F	F	7	8	3	1	5	3	3	6	1	7
112	45	20	T	F	F	8	2	2	1	5	2	3	3	1	5
157A	50	25	T	F	F	7	8	2	2	6	1	1	7	1	7
158	60	35	T	F	F	5	7	5	2	5	3	7	1	1	7
165	50	25	T	F	F	5	4	4	2	5	1	7	6	1	5
178	45	20	T	F	F	2	7	3	2	5	1	5	6	1	7
6	20	20	T	D	I	8	7	8	2	6	4	1	7	1	6
15	15	15	T	D	I	9	7	9	2	8	1	4	7	1	5
45	20	20	T	D	I	1	9	4	2	6	2	8	4	1	7
52	15	15	T	D	I	1	8	4	2	5	2	7	7	1	7
53	15	15	T	D	I	2	7	4	2	6	2	8	6	1	6
61	20	20	T	D	I	1	8	6	2	8	2	7	6	1	3
64	20	20	T	D	I	3	8	6	2	6	2	8	3	1	2
68	20	20	T	D	I	2	5	4	2	5	2	4	8	1	5
83	15	15	T	D	I	7	8	4	2	5	2	4	4	1	6
89	15	15	T	D	I	1	9	4	2	7	2	8	4	1	4
111	15	15	T	D	I	2	2	4	2	6	3	2	5	1	5
161	20	20	T	D	I	1	7	4	2	5	1	9	6	1	3
164	20	20	T	D	I	2	7	4	2	6	2	8	3	1	5

166	30	30	T	D	I	4	4	6	2	6	2	7	3	1	6
169	15	15	T	D	I	7	7	4	1	6	2	7	4	1	1

Appendix H: ANOVA Results

The results of the numerous Analyses of Variance (ANOVAs) and Multiple Range Tests (Bonferroni Procedures) that were conducted on the experimental data are contained in this appendix. Chapter 4 contained a summation of the data in this appendix. This appendix represents the sum total of all the analyses run on the experimental data obtained as part of this thesis study.

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Analysis of Variance for newtnezz.nradg - Type I Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:newthezz.f1_r1	292.7778	3	97.5926	2.421	.0652
B:newthezz.f2_r1	2436.7593	2	1218.3796	30.223	.0000
INTERACTIONS					
AB	830.27778	6	138.37963	3.433	.0025
RESIDUAL	21285.556	528	40.313552		
TOTAL (CORRECTED)	24845.370	539			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for newthezz.nradg

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	540	24.907407	.2732302	24.370537	25.444278
A:newthezz.f1_r1					
Z	135	25.703704	.5464603	24.629963	26.777444
NZ	135	23.703704	.5464603	22.629963	24.777444
SB	135	25.148148	.5464603	24.074408	26.221888
T	135	25.074074	.5464603	24.000334	26.147814
B:newthezz.f2_r1					
I	180	27.416667	.4732485	26.486780	28.346553
F	180	25.083333	.4732485	24.153447	26.013220
D	180	22.222222	.4732485	21.292336	23.152109
AB					
Z I	45	26.666667	.9464971	24.806894	28.526439
Z F	45	26.555556	.9464971	24.695783	28.415328
Z D	45	23.888889	.9464971	22.029116	25.748662
NZ I	45	28.111111	.9464971	26.251338	29.970884
NZ F	45	21.222222	.9464971	19.362450	23.081995
NZ D	45	21.777778	.9464971	19.918005	23.637550
SB I	45	27.222222	.9464971	25.362450	29.081995
SB F	45	26.333333	.9464971	24.473561	28.193106
SB D	45	21.888889	.9464971	20.029116	23.748662
T I	45	27.666667	.9464971	25.806894	29.526439
T F	45	26.222222	.9464971	24.362450	28.081995
T D	45	21.333333	.9464971	19.473561	23.193106

Multiple range analysis for newthezz.nradg by newthezz.f1_r1

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
NZ	135	23.703704	X
T	135	25.074074	X
SB	135	25.148148	X
Z	135	25.703704	X

contrast	difference	+/- limits
Z - NZ	2.00000	2.04690
Z - SB	0.55556	2.04690
Z - T	0.62963	2.04690
NZ - SB	-1.44444	2.04690
NZ - T	-1.37037	2.04690
SB - T	0.07407	2.04690

* denotes a statistically significant difference.

Multiple range analysis for newthezz.nradg by newthezz.f2_r1

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
D	180	22.222222	X
F	180	25.083333	X
I	180	27.416667	X

contrast	difference	+/- limits
I - F	2.33333	1.60764 *
I - D	5.19444	1.60764 *
F - D	2.86111	1.60764 *

* denotes a statistically significant difference.

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Analysis of Variance for newthezz.trenl - Type I Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:newthezz.f1_r1	61.78333	3	20.59444	5.126	.0017
B:newthezz.f2_r1	446.20370	2	223.10185	55.529	.0000
INTERACTIONS					
AB	44.522222	6	7.4203704	1.847	.0881
RESIDUAL	2121.3778	528	4.0177609		
TOTAL (CORRECTED)	2673.8870	539			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for newthezz.trenl

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	540	5.4240741	.0862572	5.2545873	5.5935608
A:newthezz.f1_r1					
Z	135	5.8296296	.1725143	5.4906561	6.1686031
NZ	135	5.6740741	.1725143	5.3351006	6.0130476
SB	135	5.1851852	.1725143	4.8462117	5.5241587
T	135	5.0074074	.1725143	4.6684339	5.3463809
B:newthezz.f2_r1					
I	180	6.6555556	.1494018	6.3619959	6.9491152
F	180	5.1277778	.1494018	4.8342181	5.4213374
D	180	4.4888889	.1494018	4.1953292	4.7824485
AB					
Z I	45	6.5777778	.2988036	5.9906585	7.1648971
Z F	45	5.5333333	.2988036	4.9462140	6.1204526
Z D	45	5.3777778	.2988036	4.7906585	5.9648971
NZ I	45	7.0444444	.2988036	6.4573251	7.6315638
NZ F	45	5.4222222	.2988036	4.8351029	6.0093415
NZ D	45	4.5555556	.2988036	3.9684362	5.1426749
SB I	45	6.3777778	.2988036	5.7906585	6.9648971
SB F	45	4.7333333	.2988036	4.1462140	5.3204526
SB D	45	4.4444444	.2988036	3.8573251	5.0315638
T I	45	6.6222222	.2988036	6.0351029	7.2093415
T F	45	4.8222222	.2988036	4.2351029	5.4093415
T D	45	3.5777778	.2988036	2.9906585	4.1648971

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Multiple range analysis for newthezz.trenl by newthezz.f1_r1

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
T	135	5.0074074	X
SB	135	5.1851852	XX
NZ	135	5.6740741	X
Z	135	5.8296296	X

contrast	difference	+/- limits	
Z - NZ	0.15556	0.64619	
Z - SB	0.64444	0.64619	
Z - T	0.82222	0.64619	*
NZ - SB	0.48889	0.64619	
NZ - T	0.66667	0.64619	*
SB - T	0.17778	0.64619	

* denotes a statistically significant difference.

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Multiple range analysis for newthezz.trenl by newthezz.f2_r1

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
D	180	4.4888889	X
F	180	5.1277778	X
I	180	6.6555556	X

contrast	difference	+/- limits	
I - F	1.52778	0.50752	*
I - D	2.16667	0.50752	*
F - D	0.63889	0.50752	*

* denotes a statistically significant difference.

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Analysis of Variance for newthezz.risk1 - Type I Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:newthezz.f1_r1	17.26667	3	5.75556	1.455	.2258
B:newthezz.f2_r1	390.00370	2	195.00185	49.310	.0000
INTERACTIONS					
AB	106.45556	6	17.742593	4.487	.0002
RESIDUAL	2088.0444	528	3.9546296		
TOTAL (CORRECTED)	2601.7704	539			

0 missing values have been excluded.

All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for newthezz.risk1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	540	4.7074074	.0855768	4.5392575	4.8755573
A:newthezz.f1_r1					
Z	135	4.4444444	.1711536	4.1081447	4.7807442
NZ	135	4.9333333	.1711536	4.5970335	5.2696331
SB	135	4.6666667	.1711536	4.3303669	5.0029665
T	135	4.7851852	.1711536	4.4488854	5.1214850
B:newthezz.f2_r1					
I	180	3.7611111	.1482234	3.4698669	4.0523553
F	180	4.5388889	.1482234	4.2476447	4.8301331
D	180	5.8222222	.1482234	5.5309781	6.1134664
AB					
Z I	45	3.7333333	.2964467	3.1508450	4.3158217
Z F	45	4.1333333	.2964467	3.5508450	4.7158217
Z D	45	5.4666667	.2964467	4.8841783	6.0491550
NZ I	45	3.4000000	.2964467	2.8175117	3.9824883
NZ F	45	5.6000000	.2964467	5.0175117	6.1824883
NZ D	45	5.8000000	.2964467	5.2175117	6.3824883
SB I	45	3.8000000	.2964467	3.2175117	4.3824883
SB F	45	3.7555556	.2964467	3.1730672	4.3380439
SB D	45	6.4444444	.2964467	5.8619561	7.0269328
T I	45	4.1111111	.2964467	3.5286228	4.6935994
T F	45	4.6666667	.2964467	4.0841783	5.2491550
T D	45	5.5777778	.2964467	4.9952894	6.1602661

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Multiple range analysis for newthezz.risk1 by newthezz.f1_r1

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
Z	135	4.4444444	X
SB	135	4.6666667	X
T	135	4.7851852	X
NZ	135	4.9333333	X

contrast	difference	+/- limits
Z - NZ	-0.48889	0.64110
Z - SB	-0.22222	0.64110
Z - T	-0.34074	0.64110
NZ - SB	0.26667	0.64110
NZ - T	0.14815	0.64110
SB - T	-0.11852	0.64110

* denotes a statistically significant difference.

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Multiple range analysis for newthezz.risk1 by newthezz.f2_r1

Method: 95 Percent Bonferroni

Level	Count	LS Mean	Homogeneous Groups
I	180	3.7611111	X
F	180	4.5388889	X
D	180	5.8222222	X

contrast	difference	+/- limits
I F	-0.77778	0.50352 *
I - D	-2.06111	0.50352 *
F - D	-1.28333	0.50352 *

* denotes a statistically significant difference.

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Analysis of Variance for NINCR.NORM_RESP - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NINCR.DISP_TYPE	51.527778	3	17.175926	.419	.7393
B:NINCR.COMPANY	23.333333	2	11.666667	.285	.7525
INTERACTIONS					
AB	168.88889	6	28.148148	.687	.6601
RESIDUAL	6880.0000	168	40.952381		
TOTAL (CORRECTED)	7123.7500	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NINCR.NORM_RESP

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	27.416667	.4769835	26.474804	28.358530
A:NINCR.DISP_TYPE					
Z	45	26.666667	.9539669	24.782940	28.550393
NZ	45	28.111111	.9539669	26.227385	29.994837
SB	45	27.222222	.9539669	25.338496	29.105948
T	45	27.666667	.9539669	25.782940	29.550393
B:NINCR.COMPANY					
A	60	26.916667	.8261596	25.285312	28.548021
B	60	27.583333	.8261596	25.951979	29.214688
C	60	27.750000	.8261596	26.118645	29.381355
AB					
Z A	15	25.333333	1.6523192	22.070624	28.596043
Z B	15	27.333333	1.6523192	24.070624	30.596043
Z C	15	27.333333	1.6523192	24.070624	30.596043
NZ A	15	26.666667	1.6523192	23.403957	29.929376
NZ B	15	28.000000	1.6523192	24.737290	31.262710
NZ C	15	29.666667	1.6523192	26.403957	32.929376
SB A	15	26.666667	1.6523192	23.403957	29.929376
SB B	15	27.000000	1.6523192	23.737290	30.262710
SB C	15	28.000000	1.6523192	24.737290	31.262710
T A	15	29.000000	1.6523192	25.737290	32.262710
T B	15	28.000000	1.6523192	24.737290	31.262710
T C	15	26.000000	1.6523192	22.737290	29.262710

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Multiple range analysis for NINCR.NORM_RESP by NINCR.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
Z	45	26.666667	X
SB	45	27.222222	X
T	45	27.666667	X
NZ	45	28.111111	X

contrast	difference	+/- limits
Z - NZ	-1.44444	2.66399
Z - SB	-0.55556	2.66399
Z - T	-1.00000	2.66399
NZ - SB	0.88889	2.66399
NZ - T	0.44444	2.66399
SB - T	-0.44444	2.66399

* denotes a statistically significant difference.

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Multiple range analysis for NINCR.NORM_RESP by NINCR.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
A	60	26.916667	X
B	60	27.583333	X
C	60	27.750000	X

contrast	difference	+/- limits
A - B	-0.66667	2.30708
A - C	-0.83333	2.30708
B - C	-0.16667	2.30708

* denotes a statistically significant difference.

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Analysis of Variance for NINCR.TREN1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NINCR.DISP_TYPE	10.600000	3	3.533333	1.442	.2325
B:NINCR.COMPANY	46.144444	2	23.072222	9.414	.0001
INTERACTIONS					
AB	2.1666667	6	.3611111	.147	.9894
RESIDUAL	411.73333	168	2.4507937		
TOTAL (CORRECTED)	470.64444	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NINCR.TREN1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	6.6555556	.1166856	6.4251454	6.8859657
A:NINCR.DISP_TYPE					
Z	45	6.5777778	.2333711	6.1169575	7.0385981
NZ	45	7.0444444	.2333711	6.5836242	7.5052647
SB	45	6.3777778	.2333711	5.9169575	6.8385981
T	45	6.6222222	.2333711	6.1614019	7.0830425
B:NINCR.COMPANY					
A	60	6.1166667	.2021053	5.7175846	6.5157487
B	60	6.5166667	.2021053	6.1175846	6.9157487
C	60	7.3333333	.2021053	6.9342513	7.7324154
AB					
Z A	15	5.9333333	.4042106	5.1351692	6.7314975
Z B	15	6.4666667	.4042106	5.6685025	7.2648308
Z C	15	7.3333333	.4042106	6.5351692	8.1314975
NZ A	15	6.4000000	.4042106	5.6018359	7.1981641
NZ B	15	6.8666667	.4042106	6.0685025	7.6648308
NZ C	15	7.8666667	.4042106	7.0685025	8.6648308
SB A	15	5.8666667	.4042106	5.0685025	6.6648308
SB B	15	6.2000000	.4042106	5.4018359	6.9981641
SB C	15	7.0666667	.4042106	6.2685025	7.8648308
T A	15	6.2666667	.4042106	5.4685025	7.0648308
T B	15	6.5333333	.4042106	5.7351692	7.3314975
T C	15	7.0666667	.4042106	6.2685025	7.8648308

Multiple range analysis for NINCR.TREN1 by NINCR.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
SB	45	6.3777778	X
Z	45	6.5777778	XX
T	45	6.6222222	XX
NZ	45	7.0444444	X

contrast	difference	+/- limits	
Z - NZ	-0.46667	0.65170	
Z - SB	0.20000	0.65170	
Z - T	-0.04444	0.65170	
NZ - SB	0.66667	0.65170	*
NZ - T	0.42222	0.65170	
SB - T	-0.24444	0.65170	

* denotes a statistically significant difference.

Multiple range analysis for NINCR.TREN1 by NINCR.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
A	60	6.1166667	X
B	60	6.5166667	X
C	60	7.3333333	X

contrast	difference	+/- limits	
A - B	-0.40000	0.56439	
A - C	-1.21667	0.56439	*
B - C	-0.81667	0.56439	*

* denotes a statistically significant difference.

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Analysis of Variance for NINCR.RISK1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NINCR.DISP_TYPE	11.483333	3	3.8277778	1.432	.2353
B:NINCR.COMPANY	1.477778	2	.7388889	.276	.7588
INTERACTIONS					
AB	18.700000	6	3.1166667	1.166	.3269
RESIDUAL	449.06667	168	2.6730159		
TOTAL (CORRECTED)	480.72778	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NINCR.RISK1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	3.7611111	.1218609	3.5204815	4.0017407
A:NINCR.DISP_TYPE					
Z	45	3.7333333	.2437219	3.2520742	4.2145925
NZ	45	3.4000000	.2437219	2.9187409	3.8812591
SB	45	3.8000000	.2437219	3.3187409	4.2812591
T	45	4.1111111	.2437219	3.6298520	4.5923702
B:NINCR.COMPANY					
A	60	3.6333333	.2110693	3.2165507	4.0501160
B	60	3.8333333	.2110693	3.4165507	4.2501160
C	60	3.8166667	.2110693	3.3998840	4.2334493
AB					
Z A	15	3.6000000	.4221387	2.7664347	4.4335653
Z B	15	3.6666667	.4221387	2.8331014	4.5002319
Z C	15	3.9333333	.4221387	3.0997681	4.7668986
NZ A	15	3.4000000	.4221387	2.5664347	4.2335653
NZ B	15	3.6666667	.4221387	2.8331014	4.5002319
NZ C	15	3.1333333	.4221387	2.2997681	3.9668986
SB A	15	4.0666667	.4221387	3.2331014	4.9002319
SB B	15	3.9333333	.4221387	3.0997681	4.7668986
SB C	15	3.4000000	.4221387	2.5664347	4.2335653
T A	15	3.4666667	.4221387	2.6331014	4.3002319
T B	15	4.0666667	.4221387	3.2331014	4.900[illegible]9
T C	15	4.8000000	.4221387	3.9664347	5.6335653

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Multiple range analysis for NINCR.RISK1 by NINCR.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
NZ	45	3.4000000	X
Z	45	3.7333333	XX
SB	45	3.8000000	XX
T	45	4.1111111	X

contrast	difference	+/- limits	
Z - NZ	0.33333	0.68060	
Z - SB	-0.06667	0.68060	
Z - T	-0.37778	0.68060	
NZ - SB	-0.40000	0.68060	
NZ - T	-0.71111	0.68060	*
SB - T	-0.31111	0.68060	

* denotes a statistically significant difference.

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Multiple range analysis for NINCR.RISK1 by NINCR.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
A	60	3.6333333	X
C	60	3.8166667	X
B	60	3.8333333	X

contrast	difference	+/- limits
A - B	-0.20000	0.58942
A - C	-0.18333	0.58942
B - C	0.01667	0.58942

* denotes a statistically significant difference.

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Analysis of Variance for NFLUCT.NORM_RESP - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NFLUCT.DISP_TYPE	897.0833	3	299.02778	10.330	.0000
B:NFLUCT.COMPANY	1550.8333	2	775.41667	26.786	.0000
INTERACTIONS					
AB	312.50000	6	52.083333	1.799	.1021
RESIDUAL	4863.3333	168	28.948413		
TOTAL (CORRECTED)	7623.7500	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NFLUCT.NORM_RESP

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	25.083333	.4010293	24.291451	25.875216
A:NFLUCT.DISP_TYPE					
Z	45	26.555556	.8020586	24.971791	28.139320
NZ	45	21.222222	.8020586	19.638458	22.805987
SB	45	26.333333	.8020586	24.749569	27.917098
T	45	26.222222	.8020586	24.638458	27.805987
B:NFLUCT.COMPANY					
D	60	28.500000	.6946032	27.128420	29.871580
E	60	25.416667	.6946032	24.045086	26.788247
F	60	21.333333	.6946032	19.961753	22.704914
AB					
Z D	15	31.333333	1.3892063	28.590173	34.076494
Z E	15	28.333333	1.3892063	25.590173	31.076494
Z F	15	20.000000	1.3892063	17.256840	22.743160
NZ D	15	24.333333	1.3892063	21.590173	27.076494
NZ E	15	20.666667	1.3892063	17.923506	23.409827
NZ F	15	18.666667	1.3892063	15.923506	21.409827
SB D	15	30.333333	1.3892063	27.590173	33.076494
SB E	15	26.333333	1.3892063	23.590173	29.076494
SB F	15	22.333333	1.3892063	19.590173	25.076494
T D	15	28.000000	1.3892063	25.256840	30.743160
T E	15	26.333333	1.3892063	23.590173	29.076494
T F	15	24.333333	1.3892063	21.590173	27.076494

Multiple range analysis for NFLUCT.NORM_RESP by NFLUCT.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
NZ	45	21.222222	X
T	45	26.222222	X
SB	45	26.333333	X
Z	45	26.555556	X

contrast	difference	+/- limits	
Z - NZ	5.33333	2.23978	*
Z - SB	0.22222	2.23978	
Z - T	0.33333	2.23978	
NZ - SB	-5.11111	2.23978	*
NZ - T	-5.00000	2.23978	*
SB - T	0.11111	2.23978	

* denotes a statistically significant difference.

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Multiple range analysis for NFLUCT.NORM_RESP by NFLUCT.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
F	60	21.333333	X
E	60	25.416667	X
D	60	28.500000	X

contrast	difference	+/- limits	
D - E	3.08333	1.93971	*
D - F	7.16667	1.93971	*
E - F	4.08333	1.93971	*

* denotes a statistically significant difference.

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Analysis of Variance for NFLUCT.TREN1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NFLUCT.DISP_TYPE	22.505556	3	7.5018519	1.859	.1386
B:NFLUCT.COMPANY	1.111111	2	.5555556	.138	.8715
INTERACTIONS					
AB	8.3111111	6	1.3851852	.343	.9131
RESIDUAL	678.13333	168	4.0365079		
TOTAL (CORRECTED)	710.06111	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NFLUCT.TREN1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	5.1277778	.1497499	4.8320779	5.4234776
A:NFLUCT.DISP_TYPE					
Z	45	5.5333333	.2994999	4.9419336	6.1247331
NZ	45	5.4222222	.2994999	4.8308225	6.0136219
SB	45	4.7333333	.2994999	4.1419336	5.3247331
T	45	4.8222222	.2994999	4.2308225	5.4136219
B:NFLUCT.COMPANY					
D	60	5.1833333	.2593745	4.6711662	5 6955005
E	60	5.0166667	.2593745	4.5044995	5.5288338
F	60	5.1833333	.2593745	4.6711662	5.6955005
AB					
Z D	15	5.3333333	.5187490	4.3089990	6.3576677
Z E	15	5.3333333	.5187490	4.3089990	6.3576677
Z F	15	5.9333333	.5187490	4.9089990	6.9576677
NZ D	15	5.5333333	.5187490	4.5089990	6.5576677
NZ E	15	5.4000000	.5187490	4.3756656	6.4243344
NZ F	15	5.3333333	.5187490	4.3089990	6.3576677
SB D	15	5.1333333	.5187490	4.1089990	6.1576677
SB E	15	4.6666667	.5187490	3.6423323	5.6910010
SB F	15	4.4000000	.5187490	3.3756656	5.4243344
T D	15	4.7333333	.5187490	3.7089990	5.7576677
T E	15	4.6666667	.5187490	3.6423323	5.6910010
T F	15	5.0666667	.5187490	4.0423323	6.0910010

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Multiple range analysis for NFLUCT.TREN1 by NFLUCT.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
SB	45	4.7333333	X
T	45	4.8222222	X
NZ	45	5.4222222	X
Z	45	5.5333333	X

contrast	difference	+/- limits
Z - NZ	0.11111	0.83637
Z - SB	0.80000	0.83637
Z - T	0.71111	0.83637
NZ - SB	0.68889	0.83637
NZ - T	0.60000	0.83637
SB - T	-0.08889	0.83637

* denotes a statistically significant difference.

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Multiple range analysis for NFLUCT.TREN1 by NFLUCT.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
E	60	5.0166667	X
D	60	5.1833333	X
F	60	5.1833333	X

contrast	difference	+/- limits
D - E	0.16667	0.72431
D - F	0.00000	0.72431
E - F	-0.16667	0.72431

* denotes a statistically significant difference.

Analysis of Variance for NFLUCT.RISK1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NFLUCT.DISP_TYPE	86.41667	3	28.80556	9.754	.0000
B:NFLUCT.COMPANY	229.54444	2	114.77222	38.864	.0000
INTERACTIONS					
AB	34.633333	6	5.7722222	1.955	.0749
RESIDUAL	496.13333	168	2.9531746		
TOTAL (CORRECTED)	846.72778	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

Table of Least Squares Means for NFLUCT.RISK1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	4.5388889	.1280880	4.2859633	4.7918145
A:NFLUCT.DISP_TYPE					
Z	45	4.1333333	.2561759	3.6274821	4.6391845
NZ	45	5.6000000	.2561759	5.0941488	6.1058512
SB	45	3.7555556	.2561759	3.2497044	4.2614067
T	45	4.6666667	.2561759	4.1608155	5.1725179
B:NFLUCT.COMPANY					
D	60	3.2500000	.2218549	2.8119200	3.6880800
E	60	4.3666667	.2218549	3.9285867	4.8047466
F	60	6.0000000	.2218549	5.5619200	6.4380800
AB					
Z D	15	2.2666667	.4437097	1.3905067	3.1428266
Z E	15	3.9333333	.4437097	3.0571734	4.8094933
Z F	15	6.2000000	.4437097	5.3238400	7.0761600
NZ D	15	4.1333333	.4437097	3.2571734	5.0094933
NZ E	15	5.5333333	.4437097	4.6571734	6.4094933
NZ F	15	7.1333333	.4437097	6.2571734	8.0094933
SB D	15	2.5333333	.4437097	1.6571734	3.4094933
SB E	15	3.2666667	.4437097	2.3905067	4.1428266
SB F	15	5.4666667	.4437097	4.5905067	6.3428266
T D	15	4.0666667	.4437097	3.1905067	4.9428266
T E	15	4.7333333	.4437097	3.8571734	5.6094933
T F	15	5.2000000	.4437097	4.3238400	6.0761600

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Multiple range analysis for NFLUCT.RISK1 by NFLUCT.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
SB	45	3.7555556	X
Z	45	4.1333333	XX
T	45	4.6666667	X
NZ	45	5.6000000	X

contrast	difference	+/- limits	
Z - NZ	-1.46667	0.71538	*
Z - SB	0.37778	0.71538	
Z - T	-0.53333	0.71538	
NZ - SB	1.84444	0.71538	*
NZ - T	0.93333	0.71538	*
SB - T	-0.91111	0.71538	*

* denotes a statistically significant difference.

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Multiple range analysis for NFLUCT.RISK1 by NFLUCT.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
D	60	3.2500000	X
E	60	4.3666667	X
F	60	6.0000000	X

contrast	difference	+/- limits	
D - E	-1.11667	0.61954	*
D - F	-2.75000	0.61954	*
E - F	-1.63333	0.61954	*

* denotes a statistically significant difference.

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Analysis of Variance for NDECR.NORM_RESP - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NDECR.DISP_TYPE	174.4444	3	58.14815	1.876	.1355
B:NDECR.COMPANY	1924.4444	2	962.22222	31.047	.0000
INTERACTIONS					
AB	355.55556	6	59.259259	1.912	.0816
RESIDUAL	5206.6667	168	30.992063		
TOTAL (CORRECTED)	7661.1111	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NDECR.NORM_RESP

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	22.222222	.4149435	21.402865	23.041580
A:NDECR.DISP_TYPE					
Z	45	23.888889	.8298871	22.250174	25.527604
NZ	45	21.777778	.8298871	20.139063	23.416493
SB	45	21.888889	.8298871	20.250174	23.527604
T	45	21.333333	.8298871	19.694618	22.972048
B:NDECR.COMPANY					
G	60	26.333333	.7187033	24.914164	27.752502
H	60	22.000000	.7187033	20.580831	23.419169
I	60	18.333333	.7187033	16.914164	19.752502
AB					
Z G	15	29.000000	1.4374065	26.161662	31.838338
Z H	15	25.000000	1.4374065	22.161662	27.838338
Z I	15	17.666667	1.4374065	14.828329	20.505004
NZ G	15	25.333333	1.4374065	22.494996	28.171671
NZ H	15	20.666667	1.4374065	17.828329	23.505004
NZ I	15	19.333333	1.4374065	16.494996	22.171671
SB G	15	27.666667	1.4374065	24.828329	30.505004
SB H	15	20.000000	1.4374065	17.161662	22.838338
SB I	15	18.000000	1.4374065	15.161662	20.838338
T G	15	23.333333	1.4374065	20.494996	26.171671
T H	15	22.333333	1.4374065	19.494996	25.171671
T I	15	18.333333	1.4374065	15.494996	21.171671

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Multiple range analysis for NDECR.NORM_RESP by NDECR.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
T	45	21.333333	X
NZ	45	21.777778	XX
SB	45	21.888889	XX
Z	45	23.888889	X

contrast	difference	+/- limits	
Z - NZ	2.11111	2.31749	
Z - SB	2.00000	2.31749	
Z - T	2.55556	2.31749	*
NZ - SB	-0.11111	2.31749	
NZ - T	0.44444	2.31749	
SB - T	0.55556	2.31749	

* denotes a statistically significant difference.

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Multiple range analysis for NDECR.NORM_RESP by NDECR.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
I	60	18.333333	X
H	60	22.000000	X
G	60	26.333333	X

contrast	difference	+/- limits	
G - H	4.33333	2.00701	*
G - I	8.00000	2.00701	*
H - I	3.66667	2.00701	*

* denotes a statistically significant difference.

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Analysis of Variance for NDECR.TREN1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NDECR.DISP_TYPE	73.200000	3	24.400000	4.333	.0057
B:NDECR.COMPANY	2.144444	2	1.072222	.190	.8268
INTERACTIONS					
AB	25.633333	6	4.2722222	.759	.6034
RESIDUAL	946.00000	168	5.6309524		
TOTAL (CORRECTED)	1046.9778	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NDECR.TREN1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	4.4888889	.1768702	4.1396367	4.8381411
A:NDECR.DISP_TYPE					
[illegible]	45	5.3777778	.3537404	4.6792734	6.0762822
NZ	45	4.5555556	.3537404	3.8570512	5.2540599
SB	45	4.4444444	.3537404	3.7459401	5.1429488
T	45	3.5777778	.3537404	2.8792734	4.2762822
B:NDECR.COMPANY					
G	60	4.6166667	.3063482	4.0117441	5.2215892
H	60	4.3500000	.3063482	3.7450775	4.9549225
I	60	4.5000000	.3063482	3.8950775	5.1049225
AB					
Z G	15	4.7333333	.6126964	3.5234883	5.9431784
Z H	15	5.2000000	.6126964	3.9901549	6.4098451
Z I	15	6.2000000	.6125964	4.9901549	7.4098451
NZ G	15	4.9333333	.6126964	3.7234883	6.1431784
NZ H	15	4.4666667	.6126964	3.2568216	5.6765117
NZ I	15	4.2666667	.6126964	3.0568216	5.4765117
SB G	15	4.8000000	.6126964	3.5901549	6.0098451
SB H	15	4.4000000	.6126964	3.1901549	5.6098451
SB I	15	4.1333333	.6126964	2.9234883	5.3431784
T G	15	4.0000000	.6126964	2.7901549	5.2098451
T H	15	3.3333333	.6126964	2.1234883	4.5431784
T I	15	3.4000000	.6126964	2.1901549	4.6098451

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Multiple range analysis for NDECR.TREN1 by NDECR.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
T	45	3.5777778	X
SB	45	4.4444444	XX
NZ	45	4.5555556	XX
Z	45	5.3777778	X

contrast	difference	+/- limits	
Z - NZ	0.82222	0.98783	
Z - SB	0.93333	0.98783	
Z - T	1.80000	0.98783	*
NZ - SB	0.11111	0.98783	
NZ - T	0.97778	0.98783	
SB - T	0.86667	0.98783	

* denotes a statistically significant difference.

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Multiple range analysis for NDECR.TREN1 by NDECR.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
H	60	4.3500000	X
I	60	4.5000000	X
G	60	4.6166667	X

contrast	difference	+/- limits
G - H	0.26667	0.85549
G - I	0.11667	0.85549
H - I	-0.15000	0.85549

* denotes a statistically significant difference.

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Analysis of Variance for NDECR.RISK1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:NDECR.DISP_TYPE	25.82222	3	8.607407	2.177	.0926
B:NDECR.COMPANY	183.51111	2	91.755556	23.211	.0000
INTERACTIONS					
AB	10.844444	6	1.8074074	.457	.8391
RESIDUAL	664.13333	168	3.9531746		
TOTAL (CORRECTED)	884.31111	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for NDECR.RISK1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	5.8222222	.1481961	5.5295906	6.1148538
A:NDECR.DISP_TYPE					
Z	45	5.4666667	.2963922	4.8814035	6.0519299
NZ	45	5.8000000	.2963922	5.2147368	6.3852632
SB	45	6.4444444	.2963922	5.8591813	7.0297076
T	45	5.5777778	.2963922	4.9925146	6.1630410
B:NDECR.COMPANY					
G	60	4.7333333	.2566832	4.2264805	5.2401861
H	60	5.5666667	.2566832	5.0598139	6.0735195
I	60	7.1666667	.2566832	6.6598139	7.6735195
AB					
Z G	15	3.8666667	.5133663	2.8529611	4.8803722
Z H	15	5.3333333	.5133663	4.3196278	6.3470389
Z I	15	7.2000000	.5133663	6.1862944	8.2137056
NZ G	15	5.0666667	.5133663	4.0529611	6.0803722
NZ H	15	5.5333333	.5133663	4.5196278	6.5470389
NZ I	15	6.8000000	.5133663	5.7862944	7.8137056
SB G	15	5.3333333	.5133663	4.3196278	6.3470389
SB H	15	6.2000000	.5133663	5.1862944	7.2137056
SB I	15	7.8000000	.5133663	6.7862944	8.8137056
T G	15	4.6666667	.'133663	3.6529611	5.6803722
T H	15	5.2000000	.5133663	4.1862944	6.2137056
T I	15	6.8666667	.5133663	5.8529611	7.8803722

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Multiple range analysis for NDECR.RISK1 by NDECR.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
Z	45	5.4666667	X
T	45	5.5777778	X
NZ	45	5.8000000	XX
SB	45	6.4444444	X

contrast	difference	+/- limits	
Z - NZ	-0.33333	0.82769	
Z - SB	-0.97778	0.82769	*
Z - T	-0.11111	0.82769	
NZ - SB	-0.64444	0.82769	
NZ - T	0.22222	0.82769	
SB - T	0.86667	0.82769	*

* denotes a statistically significant difference.

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Multiple range analysis for NDECR.RISK1 by NDECR.COMPANY

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
G	60	4.7333333	X
H	60	5.5666667	X
I	60	7.1666667	X

contrast	difference	+/- limits	
G - H	-0.83333	0.71680	*
G - I	-2.43333	0.71680	*
H - I	-1.60000	0.71680	*

* denotes a statistically significant difference.

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Analysis of Variance for LARGE.NORM_RESP - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:LARGE.DISP_TYPE	275.97222	3	91.990741	2.457	.0648
B:LARGE.TREN_TYPE	150.83333	2	75.416667	2.014	.1366
INTERACTIONS					
AB	546.94444	6	91.157407	2.435	.0278
RESIDUAL	6290.0000	168	37.440476		
TOTAL (CORRECTED)	7263.7500	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for LARGE.NORM_RESP

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	27.250000	.4560731	26.349427	28.150573
A:LARGE.DISP_TYPE					
Z	45	28.555556	.9121461	26.754410	30.356701
NZ	45	25.444444	.9121461	23.643299	27.245590
SB	45	28.222222	.9121461	26.421076	30.023368
T	45	26.777778	.9121461	24.976632	28.578924
B:LARGE.TREN_TYPE					
I	60	26.916667	.7899417	25.356829	28.476505
F	60	28.500000	.7899417	26.940162	30.059838
D	60	26.333333	.7899417	24.773495	27.893171
AB					
Z I	15	25.333333	1.5798835	22.213657	28.453010
Z F	15	31.333333	1.5798835	28.213657	34.453010
Z D	15	29.000000	1.5798835	25.880324	32.119676
NZ I	15	26.666667	1.5798835	23.546990	29.786343
NZ F	15	24.333333	1.5798835	21.213657	27.453010
NZ D	15	25.333333	1.5798835	22.213657	28.453010
SB I	15	26.666667	1.5798835	23.546990	29.786343
SB F	15	30.333333	1.5798835	27.213657	33.453010
SB D	15	27.666667	1.5798835	24.546990	30.786343
T I	15	29.000000	1.5798835	25.880324	32.119676
T F	15	28.000000	1.5798835	24.880324	31.119676
T D	15	23.333333	1.5798835	20.213657	26.453010

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Multiple range analysis for LARGE.NORM_RESP by LARGE.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
NZ	45	25.444444	X
T	45	26.777778	XX
SB	45	28.222222	X
Z	45	28.555556	X

contrast	difference	+/- limits	
Z - NZ	3.11111	2.54720	*
Z - SB	C.33333	2.54720	
Z - T	1.77778	2.54720	
NZ - SB	-2.77778	2.54720	*
NZ - T	-1.33333	2.54720	
SB - T	1.44444	2.54720	

* denotes a statistically significant difference.

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Multiple range analysis for LARGE.NORM_RESP by LARGE.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
D	60	26.333333	X
I	60	26.916667	X
F	60	28.500000	X

contrast	difference	+/- limits
I - F	-1.58333	2.20594
I - D	0.58333	2.20594
F - D	2.16667	2.20594

* denotes a statistically significant difference.

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Analysis of Variance for LARGE.TREN1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:LARGE.DISP_TYPE	8.816667	3	2.938889	.696	5556
B:LARGE.TREN_TYPE	68.844444	2	34.422222	8.154	.0004
INTERACTIONS					
AB	7.3333333	6	1.2222222	.290	.9413
RESIDUAL	709.20000	168	4.2214286		
TOTAL (CORRECTED)	794.19444	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for LARGE.TREN1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	5.3055556	.1531417	5.0031582	5.6079529
A:LARGE.DISP_TYPE					
Z	45	5.3333333	.3062834	4.7285387	5.9381280
NZ	45	5.6222222	.3062834	5.0174276	6.2270169
SB	45	5.2666667	.3062834	4.6618720	5.8714613
T	45	5.0000000	.3062834	4.3952054	5.6047946
B:LARGE.TREN_TYPE					
I	60	6.1166667	.2652492	5.5928991	6.6404342
F	60	5.1833333	.2652492	4.6595658	5.7071009
D	60	4.6166667	.2652492	4.0928991	5.1404342
AB					
Z I	15	5.9333333	.5304984	4.8857983	6.9808684
Z F	15	5.3333333	.5304984	4.2857983	6.3808684
Z D	15	4.7333333	.5304984	3.6857983	5.7808684
NZ I	15	6.4000000	.5304984	5.3524650	7.4475350
NZ F	15	5.5333333	.5304984	4.4857983	6.5808684
NZ D	15	4.9333323	.5304984	3.8857983	5.9808684
SB I	15	5.8666667	.5304984	4.8191316	6.9142017
SB F	15	5.1333333	.5304984	4.0857983	6.1808694
SB D	15	4.8000000	.5304984	3.7524650	5.8475350
T I	15	6.2666667	.5304984	5.2191316	7.3142017
T F	15	4.7333333	.5304984	3.6857983	5.7808684
T D	15	4.0000000	.5304984	2.9524650	5.0475350

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Multiple range analysis for LARGE.TREN1 by LARGE.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
T	45	5.0000000	X
SB	45	5.2666667	X
Z	45	5.3333333	X
NZ	45	5.6222222	X

contrast	difference	+/- limits
Z - NZ	-0.28889	0.85531
Z - SB	0.06667	0.85531
Z - T	0.33333	0.85531
NZ - SB	0.35556	0.85531
NZ - T	0.62222	0.85531
SB - T	0.26667	0.85531

* denotes a statistically significant difference.

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Multiple range analysis for LARGE.TREN1 by LARGE.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
D	60	4.6166667	X
F	60	5.1833333	X
I	60	6.1166667	X

contrast	difference	+/- limits
I - F	0.93333	0.74072 *
I - D	1.50000	0.74072 *
F - D	0.56667	0.74072

* denotes a statistically significant difference.

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Analysis of Variance for LARGE.RISK1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:LARGE.DISP_TYPE	24.772222	3	8.257407	2.686	.0483
B:LARGE.TREN_TYPE	71.144444	2	35.572222	11.570	.0000
INTERACTIONS					
AB	41.611111	6	6.9351852	2.256	.0404
RESIDUAL	516.53333	168	3.0746032		
TOTAL (CORRECTED)	654.06111	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for LARGE.RISK1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	3.8722222	.1306948	3.6141491	4.1302953
A:LARGE.DISP_TYPE					
Z	45	3.2444444	.2613896	2.7282982	3.7605907
NZ	45	4.2000000	.2613896	3.6838538	4.7161462
SB	45	3.9777778	.2613896	3.4616316	4.4939240
T	45	4.0666667	.2613896	3.5505205	4.5828129
B:LARGE.TREN_TYPE					
I	60	3.6333333	.2263700	3.1863376	4.0803291
F	60	3.2500000	.2263700	2.8030043	3.6969957
D	60	4.7333333	.2263700	4.2863376	5.1803291
AB					
Z I	15	3.6000000	.4527400	2.7060085	4.4939915
Z F	15	2.2666667	.4527400	1.3726752	3.1606581
Z D	15	3.8666667	.4527400	2.9726752	4.7606581
NZ I	15	3.4000000	.4527400	2.5060085	4.2939915
NZ F	15	4.1333333	.4527400	3.2393419	5.0273248
NZ D	15	5.0666667	.4527400	4.1726752	5.9606581
SB I	15	4.0666667	.4527400	3.1726752	4.9606581
SB F	15	2.5333333	.4527400	1.6393419	3.4273248
SB D	15	5.3333333	.4527400	4.4393419	6.2273248
T I	15	3.4666667	.4527400	2.5726752	4.3606581
T F	15	4.0666667	.4527400	3.1726752	4.9606581
T D	15	4.6666667	.4527400	3.7726752	5.5606581

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Multiple range analysis for LARGE.RISK1 by LARGE.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
Z	45	3.2444444	X
SB	45	3.9777778	X
T	45	4.0666667	X
NZ	45	4.2000000	X

contrast	difference	+/- limits	
Z - NZ	-0.95556	0.72994	*
Z - SB	-0.73333	0.72994	*
Z - T	-0.82222	0.72994	*
NZ - SB	0.22222	0.72994	
NZ - T	0.13333	0.72994	
SB - T	-0.08889	0.72994	

* denotes a statistically significant difference.

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Multiple range analysis for LARGE.RISK1 by LARGE.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
F	60	3.2500000	X
I	60	3.6333333	X
D	60	4.7333333	X

contrast	difference	+/- limits	
I - F	0.38333	0.63215	
I - D	-1.10000	0.63215	*
F - D	-1.48333	0.63215	*

* denotes a statistically significant difference.

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Analysis of Variance for MEDIUM.NORM_RESP - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:MEDIUM.DISP_TYPE	348.88889	3	116.29630	3.851	.0107
B:MEDIUM.TREN_TYPE	950.83333	2	475.41667	15.743	.0000
INTERACTIONS					
AB	376.94444	6	62.824074	2.080	.0580
RESIDUAL	5073.3333	168	30.198413		
TOTAL (CORRECTED)	6750.0000	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for MEDIUM.NORM_RESP

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	25.000000	.4095961	24.191202	25.808798
A:MEDIUM.DISP_TYPE					
Z	45	26.888889	.8191922	25.271292	28.506486
NZ	45	23.111111	.8191922	21.493514	24.728708
SB	45	24.444444	.8191922	22.826848	26.062041
T	45	25.555556	.8191922	23.937959	27.173152
B:MEDIUM.TREN_TYPE					
I	60	27.583333	.7094412	26.182453	28.984213
F	60	25.416667	.7094412	24.015787	26.817547
D	60	22.000000	.7094412	20.599120	23.400880
AB					
Z I	15	27.333333	1.4188825	24.531574	30.135093
Z F	15	28.333333	1.4188825	25.531574	31.135093
Z D	15	25.000000	1.4188825	22.198240	27.801760
NZ I	15	28.000000	1.4188825	25.198240	30.801760
NZ F	15	20.666667	1.4188825	17.864907	23.468426
NZ D	15	20.666667	1.4188825	17.864907	23.468426
SB I	15	27.000000	1.4188825	24.198240	29.801760
SB F	15	26.333333	1.4188825	23.531574	29.135093
SB D	15	20.000000	1.4188825	17.198240	22.801760
T I	15	28.000000	1.4188825	25.198240	30.801760
T F	15	26.333333	1.4188825	23.531574	29.135093
T D	15	22.333333	1.4188825	19.531574	25.135093

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Multiple range analysis for MEDIUM.NORM_RESP by MEDIUM.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
NZ	45	23.111111	X
SB	45	24.444444	XX
T	45	25.555556	XX
Z	45	26.888889	X

contrast	difference	+/- limits	
Z - NZ	3.77778	2.28763	*
Z - SB	2.44444	2.28763	*
Z - T	1.33333	2.28763	
NZ - SB	-1.33333	2.28763	
NZ - T	-2.44444	2.28763	*
SB - T	-1.11111	2.28763	

* denotes a statistically significant difference.

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Multiple range analysis for MEDIUM.NORM_RESP by MEDIUM.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
D	60	22.000000	X
F	60	25.416667	X
I	60	27.583333	X

contrast	difference	+/- limits	
I - F	2.16667	1.98114	*
I - D	5.58333	1.98114	*
F - D	3.41667	1.98114	*

* denotes a statistically significant difference.

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Analysis of Variance for MEDIUM.TREN1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:MEDIUM.DISP_TYPE	20.86111	3	6.953704	2.443	.0660
B:MEDIUM.TREN_TYPE	147.77778	2	73.888889	25.955	.0000
INTERACTIONS					
AB	16.488889	6	2.7481481	.965	.4504
RESIDUAL	478.26667	168	2.8468254		
TOTAL (CORRECTED)	663.39444	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for MEDIUM.TREN1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	5.2944444	.1257605	5.0461148	5.5427741
A:MEDIUM.DISP_TYPE					
Z	45	5.6666667	.2515209	5.1700073	6.1633260
NZ	45	5.5777778	.2515209	5.0811184	6.0744371
SB	45	5.0888889	.2515209	4.5922295	5.5855482
T	45	4.8444444	.2515209	4.3477851	5.3411038
B:MEDIUM.TREN_TYPE					
I	60	6.5166667	.2178235	6.0865470	6.9467863
F	60	5.0166667	.2178235	4.5865470	5.4467863
D	60	4.3500000	.2178235	3.9198804	4.7801196
AB					
Z I	15	6.4666667	.4356471	5.6064274	7.3269059
Z F	15	5.3333333	.4356471	4.4730941	6.1935726
Z D	15	5.2000000	.4356471	4.3397608	6.0602392
NZ I	15	6.8666667	.4356471	6.0064274	7.7269059
NZ F	15	5.4000000	.4356471	4.5397608	6.2602392
NZ D	15	4.4666667	.4356471	3.6064274	5.3269059
SB I	15	6.2000000	.4356471	5.3397608	7.0602392
SB F	15	4.6666667	.4356471	3.8064274	5.5269059
SB D	15	4.4000000	.4356471	3.5397608	5.2602392
T I	15	6.5333333	.4356471	5.6730941	7.3935726
T F	15	4.6666667	.4356471	3.8064274	5.5269059
T D	15	3.3333333	.4356471	2.4730941	4.1935726

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Multiple range analysis for MEDIUM.TREN1 by MEDIUM.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
T	45	4.8444444	X
SB	45	5.0888889	XX
NZ	45	5.5777778	X
Z	45	5.6666667	X

contrast	difference	+/- limits	
Z - NZ	0.08889	0.70238	
Z - SB	0.57778	0.70238	
Z - T	0.82222	0.70238	*
NZ - SB	0.48889	0.70238	
NZ - T	0.73333	0.70238	*
SB - T	0.24444	0.70238	

* denotes a statistically significant difference.

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Multiple range analysis for MEDIUM.TREN1 by MEDIUM.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
D	60	4.3500000	X
F	60	5.0166667	X
I	60	6.5166667	X

contrast	difference	+/- limits	
I - F	1.50000	0.60828	*
I - D	2.16667	0.60828	*
F - D	0.66667	0.60828	*

* denotes a statistically significant difference.

Analysis of Variance for MEDIUM.RISK1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:MEDIUM.DISP_TYPE	9.088889	3	3.029630	1.221	.3038
B:MEDIUM.TREN_TYPE	94.577778	2	47.288889	19.055	.0000
INTERACTIONS					
AB	44.977778	6	7.4962963	3.021	.0079
RESIDUAL	416.93333	168	2.4817460		
TOTAL (CORRECTED)	565.57778	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

Table of Least Squares Means for MEDIUM.RISK1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	4.5888889	.1174201	4.3570283	4.8207494
A:MEDIUM.DISP_TYPE					
Z	45	4.3111111	.2348402	3.8473900	4.7748322
NZ	45	4.9111111	.2348402	4.4473900	5.3748322
SB	45	4.4666667	.2348402	4.0029455	4.9303878
T	45	4.6666667	.2348402	4.2029455	5.1303878
B:MEDIUM.TREN_TYPE					
I	60	3.8333333	.2033776	3.4317391	4.2349276
F	60	4.3666667	.2033776	3.9650724	4.7682609
D	60	5.5666667	.2033776	5.1650724	5.968[illegible]609
AB					
Z I	15	3.6666667	.4067551	2.8634781	4.4698552
Z F	15	3.9333333	.4067551	3.1301448	4.7365219
Z D	15	5.3333333	.4067551	4.5301448	6.1365219
NZ I	15	3.6666667	.4067551	2.8634781	4.4698552
NZ F	15	5.5333333	.4067551	4.7301448	5.3365219
NZ D	15	5.5333333	.4067551	4.7301448	6.3365219
SB I	15	3.9333333	.4067551	3.1301448	4.7365219
SB F	15	3.2666667	.4067551	2.4634781	4.0698552
SB D	15	6.2000000	.4067551	5.3968115	7.0031885
T I	15	4.0666667	.4067551	3.2634781	4.8698552
T F	15	4.7333333	.4067551	3.9301448	5.5365219
T D	15	5.2000000	.4067551	4.3968115	6.0031885

Multiple range analysis for MEDIUM.RISK1 by MEDIUM.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
I	60	3.8333333	X
F	60	4.3666667	X
D	60	5.5666667	X

contrast	difference	+/- limits	
I - F	-0.53333	0.56794	
I - D	-1.73333	0.56794	*
F - D	-1.20000	0.56794	*

* denotes a statistically significant difference.

Multiple range analysis for MEDIUM.RISK1 by MEDIUM.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
Z	45	4.3111111	X
SB	45	4.4666667	X
T	45	4.6666667	X
NZ	45	4.9111111	X

contrast	difference	+/- limits
Z - NZ	-0.60000	0.65580
Z - SB	-0.15556	0.65580
Z - T	-0.35556	0.65580
NZ - SB	0.44444	0.65580
NZ - T	0.24444	0.65580
SB - T	-0.20000	0.65580

* denotes a statistically significant difference.

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Analysis of Variance for SMALL.NORM_RESP - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:SMALL.DISP_TYPE	41.5278	3	13.8426	.416	.7415
B:SMALL.TREN_TYPE	2776.9444	2	1388.4722	41.754	.0000
INTERACTIONS					
AB	369.72222	6	61.620370	1.853	.0918
RESIDUAL	5586.6667	168	33.253968		
TOTAL (CORRECTED)	8774.8611	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for SMALL.NORM_RESP

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	22.472222	.4298189	21.623491	23.320953
A:SMALL.DISP_TYPE					
Z	45	21.666667	.8596378	19.969205	23.364128
NZ	45	22.555556	.8596378	20.858094	24.253017
SB	45	22.777778	.8596378	21.080316	24.475239
T	45	22.888889	.8596378	21.191427	24.586350
B:SMALL.TREN_TYPE					
I	60	27.750000	.7444681	26.279955	29.220045
F	60	21 333333	.7444681	19.863289	22.803378
D	60	18.333333	.7444681	16.863289	19.803378
AB					
Z I	15	27.333333	1.4889363	24.393244	30.273423
Z F	15	20.000000	1.4889363	17.059910	22.940090
Z D	15	17.666667	1.4889363	14.726577	20.606756
NZ I	15	29.666667	1.4889363	26.726577	32.606756
NZ F	15	18.666667	1.4889363	15.726577	21.606756
NZ D	15	19.333333	1.4889363	16.393244	22.273423
SB I	15	28.000000	1.4889363	25.059910	30.940090
SB F	15	22.333333	1.4889363	19.393244	25.273423
SB D	15	18.000000	1.4889363	15.059910	20.940090
T I	15	26.000000	1.4889363	23.059910	28.940090
T F	15	24.333333	1.4889363	21.393244	27.273423
T D	15	18.333333	1.4889363	15.393244	21.273423

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Multiple range analysis for SMALL.NORM_RESP by SMALL.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
Z	45	21.666667	X
NZ	45	22.555556	X
SB	45	22.777778	X
T	45	22.888889	X

contrast	difference	+/- limits
Z - NZ	-0.88889	2.40057
Z - SB	-1.11111	2.40057
Z - T	-1.22222	2.40057
NZ - SB	-0.22222	2.40057
NZ - T	-0.33333	2.40057
SB - T	-0.11111	2.40057

* denotes a statistically significant difference.

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Multiple range analysis for SMALL.NORM_RESP by SMALL.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
D	60	18.333333	X
F	60	21.333333	X
I	60	27.750000	X

contrast	difference	+/- limits
I - F	6.41667	2.07896 *
I - D	9.41667	2.07896 *
F - D	3.00000	2.07896 *

* denotes a statistically significant difference.

Analysis of Variance for SMALL.TREN1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:SMALL.DISP_TYPE	52.06111	3	17.35370	3.436	.0183
B:SMALL.TREN_TYPE	262.34444	2	131.17222	25.975	.0000
INTERACTIONS					
AB	36.855556	6	6.1425926	1.216	.3002
RESIDUAL	848.40000	168	5.0500000		
TOTAL (CORRECTED)	1199.6611	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

Table of Least Squares Means for SMALL.TREN1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	5.6722222	.1674979	5.3414768	6.0029677
A:SMALL.DISP_TYPE					
Z	45	6.4888889	.3349959	5.8273980	7.1503798
NZ	45	5.8222222	.3349959	5.1607313	6.4837132
SB	45	5.2000000	.3349959	4.5385091	5.8614909
T	45	5.1777778	.3349959	4.5162868	5.8392687
B:SMALL.TREN_TYPE					
I	60	7.3333333	.2901149	6.7604654	7.9062013
F	60	5.1833333	.2901149	4.6104654	5.7562013
D	60	4.5000000	.2901149	3.9271320	5.0728680
AB					
Z I	15	7.3333333	.5802298	6.1875974	8.4790692
Z F	15	5.9333333	.5802298	4.7875974	7.0790692
Z D	15	6.2000000	.5802298	5.0542641	7.3457359
NZ I	15	7.8666667	.5802298	6.7209308	9.0124026
NZ F	15	5.3333333	.5802298	4.1875974	6.4790692
NZ D	15	4.2666667	.5802298	3.1209308	5.4124026
SB I	15	7.0666667	.5802298	5.9209308	8.2124026
SB F	15	4.4000000	.5802298	3.2542641	5.5457359
SB D	15	4.1333333	.5802298	2.9875974	5.2790692
T I	15	7.0666667	.5802298	5.9209308	8.2124026
T F	15	5.0666667	.5802298	3.9209308	6.2124026
T D	15	3.4000000	.5802298	2.2542641	4.5457359

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Multiple range analysis for SMALL.TREN1 by SMALL.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
T	45	5.1777778	X
SB	45	5.2000000	X
NZ	45	5.8222222	XX
Z	45	6.4888889	X

contrast	difference	+/- limits	
Z - NZ	0.66667	0.93549	
Z - SB	1.28889	0.93549	*
Z - T	1.31111	0.93549	*
NZ - SB	0.62222	0.93549	
NZ - T	0.64444	0.93549	
SB - T	0.02222	0.93549	

* denotes a statistically significant difference.

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Multiple range analysis for SMALL.TREN1 by SMALL.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
D	60	4.5000000	X
F	60	5.1833333	X
I	60	7.3333333	X

contrast	difference	+/- limits	
I - F	2.15000	0.81016	*
I - D	2.83333	0.81016	*
F - D	0.68333	0.81016	

* denotes a statistically significant difference.

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Analysis of Variance for SMALL.RISK1 - Type III Sums of Squares

Source of variation	Sum of Squares	d.f.	Mean square	F-ratio	Sig. level
MAIN EFFECTS					
A:SMALL.DISP_TYPE	1.21667	3	.40556	.101	.9595
B:SMALL.TREN_TYPE	347.01111	2	173.50556	43.128	.0000
INTERACTIONS					
AB	66.233333	6	11.038889	2.744	.0144
RESIDUAL	675.86667	168	4.0230159		
TOTAL (CORRECTED)	1090.3278	179			

0 missing values have been excluded.
All F-ratios are based on the residual mean square error.

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Table of Least Squares Means for SMALL.RISK1

Level	Count	Average	Stnd. Error	95% Confidence for mean	
GRAND MEAN	180	5.6611111	.1494995	5.3659059	5.9563164
A:SMALL.DISP_TYPE					
Z	45	5.7777778	.2989989	5.1873673	6.3681883
NZ	45	5.6888889	.2989989	5.0984784	6.2792994
SB	45	5.5555556	.2989989	4.9651450	6.1459661
T	45	5.6222222	.2989989	5.0318117	6.2126327
B:SMALL.TREN_TYPE					
I	60	3.8166667	.2589407	3.3053562	4.3279772
F	60	6.0000000	.2589407	5.4886895	6.5113105
D	60	7.1666667	.2589407	6.6553562	7.6779772
AB					
Z I	15	3.9333333	.5178813	2.9107123	4.9559543
Z F	15	6.2000000	.5178813	5.1773790	7.2226210
Z D	15	7.2000000	.5178813	6.1773790	8.2226210
NZ I	15	3.1333333	.5178813	2.1107123	4.1559543
NZ F	15	7.1333333	.5178813	6.1107123	8.1559543
NZ D	15	6.8000000	.5178813	5.7773790	7.8226210
SB I	15	3.4000000	.5178813	2.3773790	4.4226210
SB F	15	5.4666667	.5178813	4.4440457	6.4892877
SB D	15	7.8000000	.5178813	6.7773790	8.8226210
T I	15	4.8000000	.5178813	3.7773790	5.8226210
T F	15	5.2000000	.5178813	4.1773790	6.2226210
T D	15	6.8666667	.5178813	5.8440457	7.8892877

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Multiple range analysis for SMALL.RISK1 by SMALL.DISP_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
SB	45	5.5555556	X
T	45	5.6222222	X
NZ	45	5.6888889	X
Z	45	5.7777778	X

contrast	difference	+/- limits
Z - NZ	0.08889	0.83497
Z - SB	0.22222	0.83497
Z - T	0.15556	0.83497
NZ - SB	0.13333	0.83497
NZ - T	0.06667	0.83497
SB - T	-0.06667	0.83497

* denotes a statistically significant difference.

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Multiple range analysis for SMALL.RISK1 by SMALL.TREN_TYPE

Method: 95 Percent LSD

Level	Count	LS Mean	Homogeneous Groups
I	60	3.8166667	X
F	60	6.0000000	X
D	60	7.1666667	X

contrast	difference	+/- limits
I - F	-2.18333	0.72310 *
I - D	-3.35000	0.72310 *
F - D	-1.16667	0.72310 *

* denotes a statistically significant difference.

Appendix I: Frequency Tabulations

The results of the frequency tabulations conducted on the responses in the demographic questionnaire are contained in this appendix. The tabulation was done using the *Statgraphics* software package. The top of each page consists of the frequency tabulation. The bottom of each page contains the corresponding question and the allowable responses from the questionnaire.

Frequency Tabulation - SUBJECT'S AGE (Age)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	0	.0000	0	.0000
2	3	.0167	3	.0167
3	52	.2889	55	.3056
4	52	.2889	107	.5944
5	27	.1500	134	.7444
6	19	.1056	153	.8500
7	13	.0722	166	.9222
8	5	.0278	171	.9500
9	9	.0500	180	1.0000

What is your age group?

1. Under 21
2. 21-24
3. 25-28
4. 29-32
5. 33-36
6. 37-40
7. 41-44
8. 45-48
9. 49 and older

Frequency Tabulation - GENDER OF SUBJECTS (Sex)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	42	.236	42	.236
2	136	.764	178	1.000

What is your gender?

1. Female
2. Male

Frequency Tabulation - EDUCATIONAL LEVEL (Ed)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	0	.00000	0	.0000
2	2	.01111	2	.0111
3	0	.00000	2	.0111
4	2	.01111	4	.0222
5	65	.36111	69	.3833
6	84	.46667	153	.8500
7	15	.08333	168	.9333
8	11	.06111	179	.9944
9	1	.00556	180	1.0000

What is your current educational level?

1. **High school diploma**
2. **High School plus college but no degree**
3. **Associate Degree**
4. **Associate Degree plus**
5. **Bachelors Degree**
6. **Bachelors Degree plus**
7. **Masters Degree**
8. **Masters Degree plus**
9. **Doctoral Degree**

Frequency Tabulation - GENERAL AREA OF EXPERIENCE (Area)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	40	.2222	40	.222
2	108	.6000	148	.822
3	19	.1056	167	.928
4	13	.0722	180	1.000

Which of the following areas do you consider to be the primary basis of your experience?

1. Technical/Scientific
2. Managerial/Supervisory
3. Academic/Educational
4. Other ____________________.

Frequency Tabulation - EXPERIENCE IN AREA (Ar-ex)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	4	.0222	4	.0222
2	46	.2556	50	.2778
3	40	.2222	90	.5000
4	51	.2833	141	.7833
5	14	.0778	155	.8611
6	9	.0500	164	.9111
7	5	.0278	169	.9389
8	11	.0611	180	1.0000

How many years experience do you have in this area of experience?

1. less than 2
2. 2 to 4
3. 5 to 7
4. 8 to 10
5. 11 to 13
6. 14 to 16
7. 17 to 19
8. 20 or more

Frequency Tabulation - FIELD OF EXPERTISE (Fld)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	25	.13889	25	.139
2	3	.01667	28	.156
3	16	.08889	44	.244
4	24	.13333	68	.378
5	11	.06111	79	.439
6	1	.00556	80	.444
7	27	.15000	107	.594
8	53	.29444	160	.889
9	20	.11111	180	1.000

In which of the following fields do you have the most experience?

1. **Accounting**
2. **Banking**
3. **Contracting**
4. **Engineering**
5. **General Business**
6. **Marketing**
7. **Operations**
8. **Support**
9. **Other (Please specify)** ____________________

Frequency Tabulation - EXPERIENCE IN FIELD (F1-Ex)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	55	.3056	55	.306
2	44	.2444	99	.550
3	39	.2167	138	.767
4	19	.1056	157	.872
5	8	.0444	165	.917
6	4	.0222	169	.939
7	11	.0611	180	1.000

How many years experience do you have in this field?

1. less than 2
2. 2 to 4
3. 5 to 7
4. 8 to 10
5. 11 to 13
6. 14 to 16
7. 17 to 19
8. 20 or more

Frequency Tabulation - FEDERAL EMPLOYMENT (Femp)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	166	.9222	166	.922
2	14	.0778	180	1.000

Are you currently a Federal Government Employee?

1. Yes
2. No (<u>If no skip to question 13 in PART II</u>)

Frequency Tabulation - YEARS OF FEDERAL EMPLOYMENT (Fe-Xp)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
0	14	.0778	14	.0778
1	2	.0111	16	.0889
2	36	.2000	52	.2889
3	38	.2111	90	.5000
4	38	.2111	128	.7111
5	21	.1167	149	.8278
6	14	.0778	163	.9056
7	5	.0278	168	.9333
8	12	.0667	180	1.0000

How many years of Federal Employment do you have?

1. less than 2
2. 2 to 4
3. 5 to 7
4. 8 to 10
5. 11 to 13
6. 14 to 16
7. 17 to 19
8. 20 or more

Frequency Tabulation - FEDERAL EMPLOYMENT STATUS (Stat)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
0	13	.07222	13	.0722
1	52	.28889	65	.3611
2	0	.00000	65	.3611
3	114	.63333	179	.9944
4	0	.00000	179	.9944
5	0	.00000	179	.9944
6	1	.00556	180	1.0000

What is your current status?

0. No Response
1. Civilian
2. Active duty enlisted
3. Active duty officer
4. Reserve/Air National Guard enlisted
5. Reserve/Air National Guard officer
6. Other (please specify) ______________________.

Frequency Tabulation - PAY GRADE (Grade)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
0	11	.06111	11	.0611
1	0	.00000	11	.0611
2	44	.24444	55	.3056
3	8	.04444	63	.3500
4	0	.00000	63	.3500
5	0	.00000	63	.3500
6	0	.00000	63	.3500
7	0	.00000	63	.3500
8	110	.61111	173	.9611
9	6	.03333	179	.9944
10	1	.00556	180	1.0000

What is your current pay grade/rate?

0. No Response
1. GS-3 to GS-7
2. GS-8 to GS-12
3. GS/M-13 to GS/M-15
4. SES
5. E-1 to E-4
6. E-5 to E-6
7. E-7 to E-9
8. O-1 to O-3
9. O-4 to O-5
10. O-6 and above

Frequency Tabulation - MAJOR COMMAND (MAJCOM)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
0	38	.2111	38	.211
1	17	.0944	55	.306
2	55	.3056	110	.611
3	16	.0889	126	.700
4	8	.0444	134	.744
5	14	.0778	148	.822
6	7	.0389	155	.861
7	4	.0222	159	.883
8	21	.1167	180	1.000

If you are employed by the U.S. Air Force, to which Major Command are you assigned?

0. No Response
1. Air Combat Command (ACC)
2. Air Force Material Command (AFMC)
3. Air Mobility Command (AMC)
4. Air Training Command (ATC)
5. Air University (AU)
6. Pacific Air Forces (PACAF)
7. United States Air Forces Europe (USAFE)
8. Other (Please specify) ____________________.

Frequency Tabulation - GRAPHICS TRAINING (Grtng)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	11	.06111	11	.0611
2	2	.01111	13	.0722
3	53	.29444	66	.3667
4	14	.07778	80	.4444
5	8	.04444	88	.4889
6	45	.25000	133	.7389
7	47	.26112	180	1.0000

Have you ever had any training in graph construction or interpretation?

1. **Yes, formal training on graph construction**
2. **Yes, formal training on graph interpretation**
3. **Yes, formal training on graph construction and interpretation**
4. **Yes, informal training on graph construction**
5. **Yes, informal training on graph interpretation**
6. **Yes, informal training on graph construction and interpretation**
7. **NO formal or informal training on graph construction or interpretation.**

Frequency Tabulation - GRAPH CONSTRUCTION (Grcon)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	2	.0111	2	.0111
2	5	.0278	7	.0389
3	26	.1444	33	.1833
4	34	.1889	67	.3722
5	62	.3444	129	.7167
6	30	.1667	159	.8833
7	21	.1167	180	1.0000

How often do you construct graphs for presentations?

1. Every day
2. Every other day
3. Once a week
4. Once a month
5. Once every few months
6. Once a year
7. Never

Frequency distribution - GRAPH USAGE IN DECISION MAKING (Gruse)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	3	.0167	3	.0167
2	13	.0722	16	.0889
3	24	.1333	40	.2222
4	36	.2000	76	.4222
5	50	.2778	126	.7000
6	22	.1222	148	.8222
7	26	.1444	174	.9667
8	6	.0333	180	1.0000

How often do you use graphs in decision making?

1. Every day
2. Every other day
3. Once a week
4. Once a month
5. Once every few months
6. Once a year
7. Never
8. My position does not require decision making.

Frequency Tabulation - GRAPH CONSTRUCTION METHOD (Auto)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
0	7	.03955	7	.0395
1	30	.16949	37	.2091
2	140	.79096	177	1.0000

If you construct graphs do you:

1. **Construct them manually (using pencil/pen and paper)**
2. **Construct them using a computer software package**
0. **No response**

Frequency Tabulation - PRIMARY SOFTWARE PACKAGE USED (Soft1)

Software Code	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
CG	1	.00741	1	.00741
EZ	1	.00741	2	.01481
HG	65	.48148	67	.49630
LO	17	.12593	84	.62222
MSW	1	.00741	85	.62963
PA	1	.00741	86	.63704
PP	11	.08148	97	.71852
QP	8	.05926	105	.77778
SC	2	.01481	107	.79259
XL	28	.20741	135	1.00000

CG = Kalieda Graph
EZ = EZ-Quant
HG = Harvard Graphics
LO = Lotus 1-2-3
MSW = MS Word
PA = Perform Analyze
PP = Powerpoint
QP = Quatro Pro
SC = Super Calc
XL = Microsoft Excel

Frequency Tabulation - SECONDARY SOFTWARE PACKAGE USED - (Soft2)

Software Code	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
AW	1	.0132	1	.0132
CD	2	.0263	3	.0395
CH	2	.0263	5	.0658
EN	4	.052	9	.1184
FR	1	.0132	10	.1316
HG	21	.2763	31	.4079
INT	1	.0132	32	.4211
LC	1	.0132	33	.4342
LO	8	.1053	41	.5395
MAC	1	.0132	42	.5526
MC	2	.0263	44	.5789
MSW	6	.0789	50	.6579
PFS	1	.0132	51	.6711
PP	15	.1974	66	.8684
QP	4	.0526	70	.9211

AW = Apple Works
CD = Coral Draw
CH = Chart
EN = Enable
FR = Framework
HG = Harvard Graphics
INT = Interleaf
LC = Learning Curve
LO = Lotus 1-2-3
MAC = Macintosh Draw
MSW = Microsoft Works
PFS = Spinaker PFS Works
PP = Power Point
QP = Quatro Pro

Frequency Tabulation - TERTIARY SOFTWARE PACKAGE USED - (Soft3)

Software Code	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
CD	1	.0294	1	.0294
EN	1	.0294	2	.0588
FL	2	.0588	4	.1176
GR	1	.0294	5	.1471
HG	5	.1471	10	.2941
LO	6	.1765	16	.4706
MAC	2	.0588	18	.5294
MSP	1	.0294	19	.5588
MSW	1	.0294	20	.5882
PP	7	.2059	27	.7941
QP	2	.0588	29	.8529
XL	5	.1471	34	1.0000

CD = Coral Draw
EN = Enable
FL = Free Lance
GR = Grapher
HG = Havard Graphics
LO = Lotus 1-2-3
MAC = Macintosh Draw
MSP = Microsoft Presentation
PP = Power Point
QP = Quatro Pro
XL = Microsoft Excel

Frequency Tabulation - CLEAR INSTRUCTIONS (Clr)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	175	.9722	175	.972
2	5	.0278	180	1.000

Were the instructions clear and simple to follow?

1. **Yes**
2. **No (Please indicate weaknesses or suggest improvements.)**

Frequency Tabulation - LEVEL OF INTEREST - (Int)

Class	Frequency	Relative Frequency	Cumulative Frequency	Cum. Rel. Frequency
1	4	.0222	4	.0222
2	6	.0333	10	.0556
3	13	.0722	23	.1278
4	12	.0667	35	.1944
5	57	.3167	92	.5111
6	34	.1889	126	.7000
7	46	.2556	172	.9556
8	5	.0278	177	.9833
9	3	.0167	180	1.0000

What was your level of interest in the experimental task?

Very Low: 1 2 3 4 5 6 7 8 9 :Very High

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13. ABSTRACT *(Maximum 200 words)*

This thesis investigated whether a difference in data display modes or a difference in data trends affected mid-level Air Force managers trend impressions, risk assessments, and loan decisions By presenting data in four different modes, and by three data trends, a 4 x 3 factorial design experiment was prepared. 180 subjects were tested, 15 in each of the twelve treatment cells. Each subject viewed three graphs or tables and made a decision based on the trend observed, their assessment of the trend, and a decision table At the end of the experiment, they were asked for their impression of the trend and their assessment of the risk involved in each of the three data sets The subjects also completed a demographic questionnaire. Using an automated statistical analysis package, a multi-factor analysis of variance was conducted. It was shown that mode of presentation did have an affect on the subjects' loan decisions, trend impressions, and risk assessments. Trend type was also a significant factor in each response category. A one-way analysis of variance was conducted on the demographic data for each area It was found that age, gender, area of expertise, and graphics training were significant factors in some response areas

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